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Manila is to have an electric lighting system and a trolley road. Here is the best way of bringing peace and quiet to that uneasy city, and we hope to hear of a general adoption of this means throughout the islands. What people could resist the uplifting influences of these two great agencies? With the electric lamp to shed the beneficent rays of civilization over the city and the trolley to carry modern ideas into the country may we not confidently hope for a final pacification.

True some individuals may object to these improvements, but that should not discourage the Philippine Commission, as instances of this kind are not unknown in our own country. Not long since an estimable lady in Connecticut objected to the incandescent lamp on account of its smell.

But our Filipino brothers are not so supersensitive, and the commission may proceed with its plans, confident of a glorious success.

NEW PHENOMENA IN GASES AT HIGH TEMPERATURES.

In a communication from Dr. John Trowbridge, which appears on another page of this issue, are described some very interesting studies of gases subjected to powerful discharges from condensers. This communication is interesting, not only on account of the results which have been obtained by Dr. Trowbridge, but also as illustrating the part electricity is now playing in scientific research. In this work the spectrum of hydrogen was examined at high temperatures without any chemical action taking place, which would be the case if hydrogen were burned.

In these researches the gases were first enclosed in glass tubes, but it was found that these could not withstand the severe stresses and high temperatures to which they were subjected. The glass tubes were then replaced by tubes made of quartz, which have been found quite satisfactory. Although these tubes were made with the oxyhydrogen flame, they can be made more easily and more satisfactorily in the electric furnace. We have here, then, electricity not only necessary for conducting the experiment, as it enables the investigator to obtain conditions which could not otherwise be reached, but also useful in preparing the apparatus necessary for this work.

The results of Dr. Trowbridge's work are of great scientific interest and they may be of value in the important researches which are now being carried out to obtain a more efficient method of lighting. This problem in engineering is probably second in importance only to that of the direct production of electricity from fuel, and any work which leads to the discovery of new phenomena in light has great interest for the engineer.

Paris, with 164 generators, has a power station output of 35,000 kilowatts. Seven of New York city's modern machines can equal this.

SOME RESULTS IN WIRELESS TELEGRAPHY.

The report of the work accomplished by Mr. William Marconi during the expedition of the Italian cruiser Carlo Alberto last summer has been published. This cruiser, as will be remembered, was put at the service of Mr. Marconi by the Italian Government, and from June 10 to September 10 was employed in a trip from Naples through the Mediterranean to England, and thence through the North and Baltic seas to Kronstadt, Russia, which point it reached July 12. The vessel returned from Kronstadt over practically the same route to Italy, and during the entire voyage exhaustive tests were made of the Marconi system. The new magnetic detector, devised by Mr. Marconi, was found to be much more sensitive than the metallic powder coherers.

It was demonstrated that messages could be transmitted in one direction, at least, over 750 miles of land and water. These messages as received were not perfect, but were readable. It was found that night messages could be transmitted to a much greater distance than day messages, this effect being attributed by Mr. Marconi to the action of the sun on the transmitting and receiving wires. The farthest distance to which signals could be sent during the daytime with the power now employed at Poldhu was about 630 miles across water.

Although the instruments used in these tests were syntonized, it is stated that in more than one place in England, where the instruments were not tuned by the Marconi company, many of the signals sent out from the Poldhu station were received and read. These tests, however, were for distance, not for secrecy, and the fact that some messages were received by other stations in England merely indicates that in this case the enormous power of the transmitting station at Poldhu was

sufficient to affect these receiving stations, although they had not been tuned.

A later report announces that the Minister of Marine, at Rome, has received a despatch from the captain of the Carlo Alberto, which is now at Sydney, N. S., stating that communication was maintained with Poldhu throughout the voyage, and even after entering the port of Sydney. Whether these messages were received at night or day does not appear. These are noteworthy results and offer additional proof of the possibility of transatlantic communication. We can not doubt that there will be a wide field for the application of wireless systems of telegraphy, which can be used where other methods are impracticable.

At all events, supposing that no commercial use should be made over such long distances, we nevertheless do not agree with our London contemporary, the *Electrician,* which holds that Mr. Marconi's recent work is of little value. Scientifically, the results are of great value, as they show us to what distances signals can be sent and the power required for their transmission.

Mr. Marconi has truly done some remarkable work, and he deserves the honor which he is now receiving.

THE SCRAP HEAP.

Although American engineers are, as a rule, indifferent to European criticism, it is well to know the opinions of our commercial rivals.

The following from the London *Electrical Review* is a rather sharp arraignment of one of our pet institutions, the scrap heap:

So much has been written under American auspices as to the Englishman's ignorance of the value of a scrap heap, that were it all true there would be nothing left for us to do but to go out of business forthwith.

Much is being constantly written concerning the rapid scrapping of obsolete tools to make room for newer tools of greater speed. A great deal of this is nonsense. The regular run of ordinary machine tools is not being so rapidly improved that it pays to scrap them every two or three years. Yet it is absolutely necessary to scrap many American tools in this period of time, purely because they are worn out and unfit to do good work. Just as the cottar's pig was killed to save its life—commercially, of course—so the scrap heap is made a virtue, because it really is a necessity.

In looking over a large number of machine shops, it is obvious that there are necessities of far greater importance than the scrapping of the old machinery. New tools have been put down under a leaking roof. They are crowded into a dark corner where not one-half of their utility and convenience can be secured. They are even placed on a dirty floor which will help quickly to spoil them. The excessive cost of manufacture is by no means always to be set down to the fault of tools. It is just as often the fault of arrangements. People who pride themselves on the excellence of their products, are content to carry on their business in a veritable rabbit warren of old dilapidated buildings, with small grimy windows, uneven patched floors, and unventilated rooms communicating in series by means of up and down bits of dark stairway. No supervision is possible. Materials are carried to and fro at great expense, and purchasers are gravely assured, though the price asked may be high, it does not represent an extravagant profit. Of this there is very little doubt. But the high prices ought to represent an extravagant profit, and only fail to do so, because of the badly arranged workshops. New tools in such a shop are, if not a useless expense, at least not the most important want. Yet the proprietors of these shops never seem able to grasp the significance of the position. They know there is something wrong. They are tempted to think that they need some new tools, but do not realize that their buildings are at fault.

To show the error of following American precedent, let the automatic machine be considered. This machine cuts articles, such as bolts, out of solid rods, and it cuts a large weight of material to waste. For small articles the system is good, but it has been carried too far. Large bolts cut out of the solid bar are unsafe and, like humans, are apt to lose their heads without warning. A good forging machine makes sound work and can be cheaply combined with screwing machines, while the hopper automatic may be employed on many articles now faultily made on rod-feed machines.

Then, again, while automatic machines with rod feed are excellent for certain small parts, it is found that the stock used in them is so soft that the resulting products are not what they should be, and soft yellow brass is used for parts that should be of good gun-metal. Manufacturing engineers who are considering reorganization should remember these points, and not too hastily throw away good quality for the sake of cheapness which will rob them of their character. The craze for cheapness and rapid delivery has had a certain free run which is beginning to show results. Purchasers are beginning to find out something of durability, wear, breakage and repairs, and it is apparently not resulting badly for the despised Englishman.

Uninstructed writers in the daily press have been very garrulous on the subject of scrap heaps. They are evidently ignorant of the two uses to which a scrap heap is put. The only one they know of is to receive obsolete material. The other use is to receive worn-out material. The Americans are great scrappers, but it is rather because of this second necessity which, however, is usually concealed behind the pretended first cause. It may pay the Americans to manufacture cheap stuff of no durability; they talk freely of the Englishman's ignorance of the use of a scrap heap, yet half the bridges in America would be promptly scrapped in Great Britain. It is all a question of circumstances. The Americans may have been right in the construction of cheap locomotives, right for America, but wrong for most other countries. That they have been wrong in their ideas of machine tools is proved by the rapid increase in their weight since they were brought into competition with English tools.

Further, the more settled parts of the states are differentiating their practice from the newer states in every line, and modern practice is approximating to European standards every year. Bridges of masonry are now quite common in America.

Our contemporary, the *Engineer,* states that, of the concerns absorbed by the big trusts in America, those with the oldest appliances were paying the best dividends, and finds that there is, perhaps, a limit to the commercial value of early scrapping. Americans who come over to this country are too usually imbued with a sense of American superiority in everything, and they have been declared by one of themselves to be useless for the first three years, which time they require to learn their way about. The sensible ones find out that practice is a matter of environment. Blindly to follow American methods is to court failure. There is much to be learnt from them, and much to be as carefully avoided; and on the question of scrapping, we should advise most of the old-fashioned firms to start with their buildings, and to be cautious and discriminating before exchanging tools that are still good for others that will wear out too rapidly. Before purchasing a new tool that is promised to do double the work of the old one, make a genuine test of the old tool, to see whether it will not do double or treble what it has been hitherto set to do. Very much of insufficient output is caused by not trying to do better.

The author of the above had the work of the mechanical engineer in mind. It would be interesting to know how this argument would apply to electrical machinery of American manufacture.

Our esteemed contemporary, the *American Machinist,* published on November 6 its twenty-fifth anniversary number. This journal is to be congratulated on the splendid appearance of this number. The high position which it occupies in its field of endeavor is the result of hard work and conscientious application of its facilities to the satisfaction of its readers.

THE SIZE OF ATOMS.*

BY H. V. RIDOUT.

Previous investigations into this subject have been made at times when the state of knowledge offered only indirect means of solution, and as no simple datum measurement bearing upon the subject was available, the results were largely inferential. To this may be ascribed the wide latitude the authors allowed themselves in their results. Thus, Loschmidt† calculated that the molecules of air must be separated, from centre to centre, by an average distance, which would require from five to one thousand millions to form a single line one centimetre long.

This result was arrived at from considerations arising out of the kinetic theory of gases.

Lord Kelvin (Sir William Thomson)‡ arrived at the conclusion that atoms or molecules—as representing the smallest quantities of matter possessing the attributes of the whole mass—had a diameter which would require from ten to one hundred millions to form our one-centimetre line.

This value was deduced from: (*a*) the undulatory theory of light, (*b*) the contact theory of electricity, (*c*) the kinetic theory of gases, and (*d*) capillary attraction.

It is not proposed here to criticise these results or these methods in any way. They are quoted merely to give an opportunity for the remark that the "atom" and the "molecule" of the authors are almost certainly aggregations of, and therefore considerably larger than, the dissociated atoms, or ions, chosen for the present investigation. The results now obtained refer to a dissociated atom as the smallest quantity of matter which can take part in an electrolytic action.

The atom chosen is hydrogen, and the measurement arrived at is that it requires, in round numbers, 114,500,000 to form our one-centimetre line. This conclusion is an outcome of the dissociation theory of electrolysis, with measurements directly derived from well-known electrical formulæ. Briefly stated, this method consists in finding a pair of spheres which would be charged by the quantity of electricity known to be necessary to electrolyze a given quantity of the body under examination—in this case water—to the known difference of potential of its ions; and from this quantity the size of the ions, and hence the atoms, is directly arrived at subject to the following:

It is assumed that:

(*a*) The dissociation theory is true.

(*b*) The atoms are spherical.

(*c*) Water matter is a non-conductor of electricity.

(*d*) Water has twice the dielectric capacity of space.*

(*e*) The ions of water are HO and H.

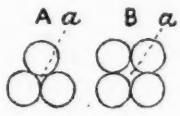


FIG. 1.

(*f*) Water being practically incompressible, its component particles are in contact.

(*g*) The ions HO and H occupy equal volumes.

Of these points (*a*) is a condition precedent. (*b*) As nothing is really known, the sphere is taken as the simplest figure to deal with. Any other figure, provided it is regular, can only vary the result by a few per cent. (*c*) As ice at a low temperature is a non-conductor of electricity, conductivity is an accident of state, and not inherent to the matter composing water. (*d*) Is taken as an approximate value in the absence of exact data. (*e*) These are taken for simplicity. The other possible ions are dealt with at the end. (*f*) This must hold good till it can be shown that water in some state has a greater density than water as we know it. (*g*) This is discussed at the end.

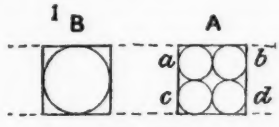


FIG. 2.

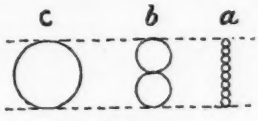


FIG. 3.

To liberate one gramme of hydrogen from water requires 96,500 coulombs. As one-ninth of the water consists of hydrogen (H = 1, O = 16), 10,722 coulombs will thus be required to decompose one gramme of water. The difference of potential of the water ions may be taken at the round number of 1.5 volts, or each ion as charged ± 0.75 volt above zero. One coulomb is capable of charging to one volt a sphere, isolated in space, whose diameter equals 18×10^{11} centimetres, and to 0.75 volt a similar sphere whose diameter is 24×10^{11}. But if the dielectric surrounding the sphere has a greater capacity than space, the size of the sphere may be reduced in like proportion. It may be taken that the ions—having regard to their size—are isolated at an infinite distance from the nearest inductive surface. The surrounding dielectric is water with a capacity of 2, and therefore our sphere, placed under the conditions of an ion, may be reduced in size by one-half, and will only need to have a diameter of 12×10^{11} to be raised 0.75 volt by one coulomb.

As the quantity of electricity we are dealing with is 10,722 coulombs, and as the capacities of isolated spheres are proportional to their diameters, we need a sphere whose diameter in round numbers is 13×10^{15} to hold the ± electricity concerned in the decomposition of one gramme of water.

Regarding the atoms as spherical, it will follow that, no matter how closely they may be packed, there must remain channels, as at *a* or *a* (Fig. 1). These may be called interatomic channels, to distinguish them from the intervals separating the atoms—whether dissociated as ions, or aggregated as molecules—in which they perform their excursions under the influence of heat or other disturbing agency.

As our object is to get a measure of the spheres in a direct line, it will be convenient to regard the atoms as arranged at B (Fig. 1), and to base our proposition on this arrangement. The results can easily be adapted for the case A by a simple arithmetical operation.

Proposition—The total volume of spheres necessary to fill a given cube equals that of the single sphere about which the cube is described. Let A (Fig. 2) be the given cube, and the spheres to consist of two layers, *a b* and *c d*. Here the total number of spheres is eight, and reckoning the diameter of the inscribed sphere B as unity, their total volume $= 8 \times (\frac{1}{2})^3 \cdot \frac{1}{6}\pi = \frac{8}{1} \times \frac{1}{8} \times \frac{1}{6}\pi = \frac{1}{6}\pi$, which is also the volume of a sphere of

*Paper read before the Physical Society of London, October, 1902.

†*Sitzungsberichte der Wiener Akademie*, 1865.

‡*Nature*, 1883.

*This value was arrived at from purely theoretical considerations, as an approximation to the Clerk Maxwell relation of inductive capacity to refractive index; and from analogy with other binary compounds, which, measured in the gaseous state, all appear to conform to this relation.

Since then Mr. W. C. D. Whetham has informed me that several independent measurements of water (as a liquid) give a very much higher value. Blondlot, however, by using electromagnetic waves found for ice 2 nearly, and C. Gutton by similar means found values of 2.25 to 3.1, the lower number corresponding to longer waves.

See *Comptes Rendus*, 1894, vol. cxix, p. 595, and 1900, vol. cxxx, p. 1119.

unit diameter. Similarly, if the cube be divided into n layers, we have n^2 as the number in each layer, and since there are n layers, the total number $= n^3$. As the volume of each $= \left(\frac{1}{n}\right)^3 \cdot \frac{1}{6}\ \pi$, we have as the total volume $\left(\frac{1}{n^3} \cdot \frac{1}{6}\ \pi\right) n^3 = \frac{1}{6}\ \pi$ as before.

The volume of the sphere B (Fig. 2) represents an actual volume of matter, and the difference between the volume of the cube and the volume of the sphere represents simple space. In the case under consideration, matter is to space as $\frac{1}{6}\ \pi$ to $1 - \frac{1}{6}\ \pi$, $= 22 : 20$ in round numbers,* and, as just shown, is independent of the number of spheres required to fill the cube.

Corollary—The electrical capacities of isolated spheres being proportional to their diameters, it follows as a corollary that any column of spheres, as a or b (Fig. 3), has the same capacity as the circumscribing sphere c (removed for convenience of illustration); for the elements of the column are fractions of the diameter of the sphere, and collectively $= 1$, $=$ diameter of sphere. This gives us a means by which we can practically substitute a line, as a, for a sphere c, to simplify the subsequent operations.

According to the dissociation theory, part of the atoms comprised in the electrolyte dissociate from the molecules according to their kinds, and in doing so become ions, by becoming charged with equal and opposite charges of electricity at the instant of separation. During electrolysis the ions yield up their charges to neutralize equal and opposite quantities of electricity at the electrodes, and thus return again to the simple atomic state.

For the present the ions of water will be regarded as HO and H, this being the constitution generally adopted in the dissociation theory, but not essential to it. For the purpose of this investigation it will be convenient to take two one-centimetre cubes of water, shown graphically in Fig. 4. Here the relative weights of the ions are 17:1—the latter being hydrogen; but as the water weighs two grammes and the hydrogen is one-eighteenth of the whole, its weight $= \frac{1}{9}$ gramme. We have found that the quantity of electricity to liberate this will charge a sphere of 13×10^{15} centimetres diameter, if placed under the conditions of a solitary ion.

If we suppose the water to be completely dissociated into ions, the actual volume of hydrogen ions will be represented by the sphere inscribed in B (Proposition 1), and, as we have just seen, the quantity of electricity to charge this mass of hydrogen will charge to a like potential a sphere of 13×10^{15} centimetres diameter; but by the corollary this quantity will charge 13×10^{15} spheres each equal to B, $= 1$ centimetre diameter. Similarly, we may apply the corollary further to each of the one-centimetre spheres, and get as a result an equal number of columns, each one centimetre high; and thus the question for solution resolves itself into this—how thick must the columns be (see Fig. 5)

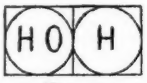


Fig. 4.

to fill the cube A, whose side measures one centimetre? Clearly the thickness of the column b is the square root of the number that we have to stand on the given base. We have found this number to be 13×10^{15}, the square root of which is approximately 114,500,000, and as the thickness of the column is the diameter of its elements (atoms), we have 114,500,000 millions as the number of hydrogen atoms required to form a line one centimetre long.

The line of investigation here adopted seems capable of determining the size of atoms with great exactitude, but until the constants are accurately measured, it has seemed advisable to deal with the matter in approximate numbers only.

I thankfully acknowledge my obligation to Mr. Boys, F. R. S., and Mr. Whetham, F. R. S., for friendly criticism, and to the latter for pointing out, that in the foregoing the fundamental points of the argument—the isolation of the ions, and the uniform distribution of their charges—are assumed rather than proved.

The dissociation theory requires that

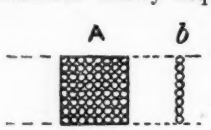


Fig. 5.

the ions shall be beyond the range of each other's influence. This is singularly in accord with all observation, that a current of infinitesimal electromotive force can decompose an electrolyte, whatever may be the difference of potential of its component atoms. It is also found that the amount of decomposition with a given quantity of current is the same, whatever the concentration of the electrolyte, and, therefore, the relative approximation of the ions. Such facts are consistent with isolation alone, and, once this is proved, the self-repulsiveness of the elements of a charge ensures the symmetrical distribution of the charge about its sphere.

There only remains the question of the sufficiency of the charge to electrify the atoms without breach of continuity. For this one must fall back on analogy, as no direct proof seems possible.

It has never been questioned that unit charge is sufficient for continuous distribution about a unit sphere. In the present case it can be shown that the density of the charge upon the ions is enormously greater than in the typical case just quoted.

It may appear that our sphere of 13×10^{15} centimetre only fixes the superior limit of size of the atom in the case considered, but, in reality, it fixes both the limits. It is the smallest sphere which can hold the given quantity of electricity at the given potential, and can, therefore, be subdivided into the fewest spheres, which can at once hold the given charge and fill the given cube. Thus it fixes the superior limit of size of the atom. Further, it is the largest sphere which can be charged to the given potential with the given quantity of electricity, and this, for like reasons, fixes the inferior limit of size of the atom. Thus, under the given conditions, 114,500,000 per linear centimetre expresses both the limits, and is, therefore, the true value.

Considerations arising out of this enquiry point to the probability that the negative ion of water is not HO, as assumed. It is interesting to note that as the ions acquire equal and opposite charges, they must have equal capacities. It seems scarcely possible in an equality with H common to both sides that H, consisting of a single atom, should have the same capacity as HO, comprising two atoms.

HO and H may be intermediate stages of the dissociation, but seeing that the H ion is always positive in the case under consideration, the O in the negative ion must have a capacity in excess of its linked H atom, otherwise the ion would not be negative. As both O and HH are under like conditions of isolation, and the capacity of O = H and H, the oxygen atom must have double the diameter of the hydrogen atom, and, therefore, eight times the volume ($2^3 : 1^3$). But as eight volumes of oxygen matter equal in weight sixteen volumes of hydrogen matter, the real density of oxygen matter is only twice the density of hydrogen matter.

If this view should be established, we should have 255,000,000, and 127,500,000, as the numbers of hydrogen and oxygen atoms, respectively, required to form our one-centimetre line.

These observations are not offered as criticisms of the dissociation theory, but appear to the author as a legitimate outcome of it, and as tending to support the view that matter, in its ultimate division, comprehends particles differing in size.

* About fifty-two per cent matter. In the case of A, Fig. 1, about seventy per cent will be matter.

An Electrical System for Heavy Railway Work.

By Wm. Hand Browne, Jr.

THE electrical operation of railroads is a topic which is receiving a good deal of attention at this time. Reports are continually coming in regarding new projects, both in this country and abroad, and various systems have been described and discussed, both in the technical press and by the engineering societies. One system, however, seems to have been overlooked in this country, although in Europe it has received considerable attention and will be put to a practical test in several localities.

Although this system was suggested a number of years ago, it may be interesting at this time to describe it briefly and point out some of the advantages claimed for it by its inventor. Mr. H. Ward Leonard, in a paper before the American Institute of Electrical Engineers, in February, 1894, discussed the subject of operating long electric railways and suggested the use of his variable speed control as a satisfactory solution of the problem.

ELECTRIC LOCOMOTIVE CONSTRUCTED BY THE SOCIÉTÉ ANONYME DE LOCOMOTION ELECTRIQUE, PARIS, EQUIPPED WITH THE WARD LEONARD SYSTEM.

In the Ward Leonard system, as then described, power was to be transmitted by single-phase alternating currents, using step-up and step-down transformers, with a transmission voltage of not less than 20,000. The potential of the trolley wire was about 500, with step-down transformers at necessary intervals. On the locomotive, in addition to the direct-current motors which drive the axles, was placed a motor-generator set, the driving motor being a single-phase synchronous motor, direct-connected to a separately excited generator. A small exciter furnishes current for the motor and generator field and for the field of the motors connected to the axle. The brushes of the driving motors are connected directly to those of the generator. The synchronous motor runs continually and drives the generator. As the latter is separately excited, the voltage at the brushes can be varied at will. Control of the locomotive is thus secured by means of a variable electrical coupling, which operates as follows:

When the locomotive is standing still the field of the generator is not excited, and there is no electromotive force set up in its armature, although this is revolving at a normal speed. In striking the train, a small current is sent through the field of the generator. This will cause a current to flow through the armature of the motor or motors, as the case may be. The fields of the latter are constantly excited by the small exciter, as mentioned above. By varying the resistance in the field of the generator, the current passing through the motor armature can be increased until sufficient torque is developed to start the train. The voltage required for this will be small, as there is no counter-electromotive force in the motor armature, and therefore the output of the generator will also be small. Hence the power drawn from the line to start the train will be but a small part of that required to run the train at full speed. As the train speeds up, the excitation of the generator is increased, thereby increasing the voltage until the train reaches its final speed.

As the motor field is always at full strength, a good starting effort can be secured. There is no rheostatic loss except that taking place in the generator field. Control of the system is easy and sure, as the controller handles comparatively small currents. The motor is reversed by reversing the generator fields, and in this way reversing the current through the motor armature. The fields of the latter are always excited in the same way.

One feature of this system is the method used for braking the train and the opportunity thus offered to return the

energy stored up in this large, moving body to the line. In order to apply the braking effect and thus stop the train, it is only necessary to decrease the excitation of the generator, and in this way lower its voltage. The driving motor then begins to act as a generator, forcing current back through the generator armature and driving the latter as a motor. This, through its couplings, drives the synchronous motor as a generator and pumps back in this way into the line the energy which, with mechanical braking, would be wasted at the brake shoes.

To see in what way this method of operating the train offers advantages over steam traction, it will be well to examine a few of the difficulties which to-day confront the railway engineer. The standing charges in the operation of steam roads are so great as compared with the cost of power that the cost of operation varies almost directly as the train miles. For this reason the tendency in recent years has been to increase the size and weight of trains. To operate these heavy trains has called for large and powerful steam locomotives, and it seems to-day as though the limit in these has been reached. The wheel-base of the locomotive is limited by the curves of the road, and the tractive effort is limited by the weight resting upon the drivers. To meet the heavy strains upon the road-bed by the concentrated load of the locomotive, heavier rails have been put down and more substantial bridges have been erected.

In starting the train with the steam locomotive, the power is applied more or less suddenly, and, unless the engineer is careful, the drivers of the locomotive will begin to skid, the starting effort being thus decreased, as it is well known that a skidding wheel meets with less resistance than when the same wheel is rolling normally on the rail. After the train is in motion, the following effects are present and must be provided for. The power is applied to the wheels alternately on one side of the locomotive and on the other. This sets up a shouldering action which causes objectionable strains on the track. There are also unbalanced vertical forces acting on the drivers, which pound the rail, and, in addition, set up a more or less rocking of the locomotive, with a consequent wear and tear on the track. The tractive effort of the locomotive comes in a series of jerks, which is less effective than the steady pull produced by an electric locomotive.

In stopping the train, retardation is applied through the brakes, and this must be carefully graded to prevent skidding of the wheels, for, as mentioned above, in starting, the maximum braking effort can not be secured by locking the wheels. Here the greatest braking effort is secured just before the train comes to a standstill, and not when it is running at its maximum speed, as should be the case.

In applying the Ward Leonard system to heavy railway work many of the disadvantages just mentioned can be avoided. As each axle will be driven by an independent motor, the wheel-base will not be limited as in the steam locomotive. If thought desirable, indeed, each wheel of the locomotive can be driven independently, and the wasteful effect of skidding of one wheel on each axle in passing around curves will be eliminated. It is this loss which increases the train resistance so considerably in rounding curves.

Since the wheel-base of a locomotive constructed on the Ward Leonard system is not limited, the weight of the locomotive can be distributed over a longer section of track, and in this way avoid the severe strains on the track which are caused by the concentrated weight of the steam locomotive. This distribution of the weight of the locomotive can be carried still further by distributing the locomotives throughout the train. These can be operated from one point and will thus work together smoothly.

The method of starting these electric locomotives enables an increasing acceleration to be secured. As is well known, this method of starting a train will bring it to its final speed more quickly and with less discomfort to the passengers than when a constant acceleration is applied. By the Ward Leonard system, an acceleration proportional to the momentum can be secured. The same is true in retarding or braking the train. By causing the motors to act as generators, the retarding effort will be greatest at the highest speeds, and the train can be brought to rest easily and quickly.

As all the driving motors are controlled from one point, they will all perform the same amount of work. There will be no pounding on the rails, no rocking of the locomotive due to unbalanced parts, and the tractive effort will be constant, and not a series of jerks. If the wheels are independently driven there will be less resistance offered at curves.

The inventor claims that this system can operate trains of the same weight as those now found practicable with but half the strain on the road-bed and for half the power expended. This would mean a reduction in the cost of maintenance of about one-half of that now incurred; or, to put the matter in another way, for the same wear and tear on the road-bed and the same cost of operating, trains of twice the weight can be handled.

In addition to the saving thus indicated, by using the motors for brakes, as described above, a considerable part of the energy represented by the momentum of the train can be returned to the line. The desirability of effecting a saving in this way was recognized by all engineers. Mr. Frank J. Sprague, in his early tests on the Third Avenue Elevated Road, New York city, found that about eighty-three per cent of all the energy consumed in operating the train was utilized in overcoming gravity and inertia; but up to this time no practical method of saving even a part of this has been found. Elevators have been operating on the Ward Leonard system for the past eight years, and have been doing this work without any difficulty, jumping back into the system without evil effects.

A good many engineers have held that in operating the Ward Leonard system there would be serious sparking at the brushes of the generator at starting, due to the heavy currents drawn from the armature and the low field strength of the generator. In the operation of elevators by this system, this trouble is not met with. The generator operates smoothly at all voltages, with practically no sparking. The reason for this is attributed by Mr. Leonard to the low difference of potential between the commutator segments. It is well known that when a constant potential is applied to a motor and the field is weakened, very bad sparking occurs. In this system, although the field is weakened, the potential is also lower, and in spite of the fact that heavy currents are being drawn out and that the neutral point on the commutator must be shifted very considerably, the difference of potential between commutator segments is not sufficient to cause any objectionable sparking.

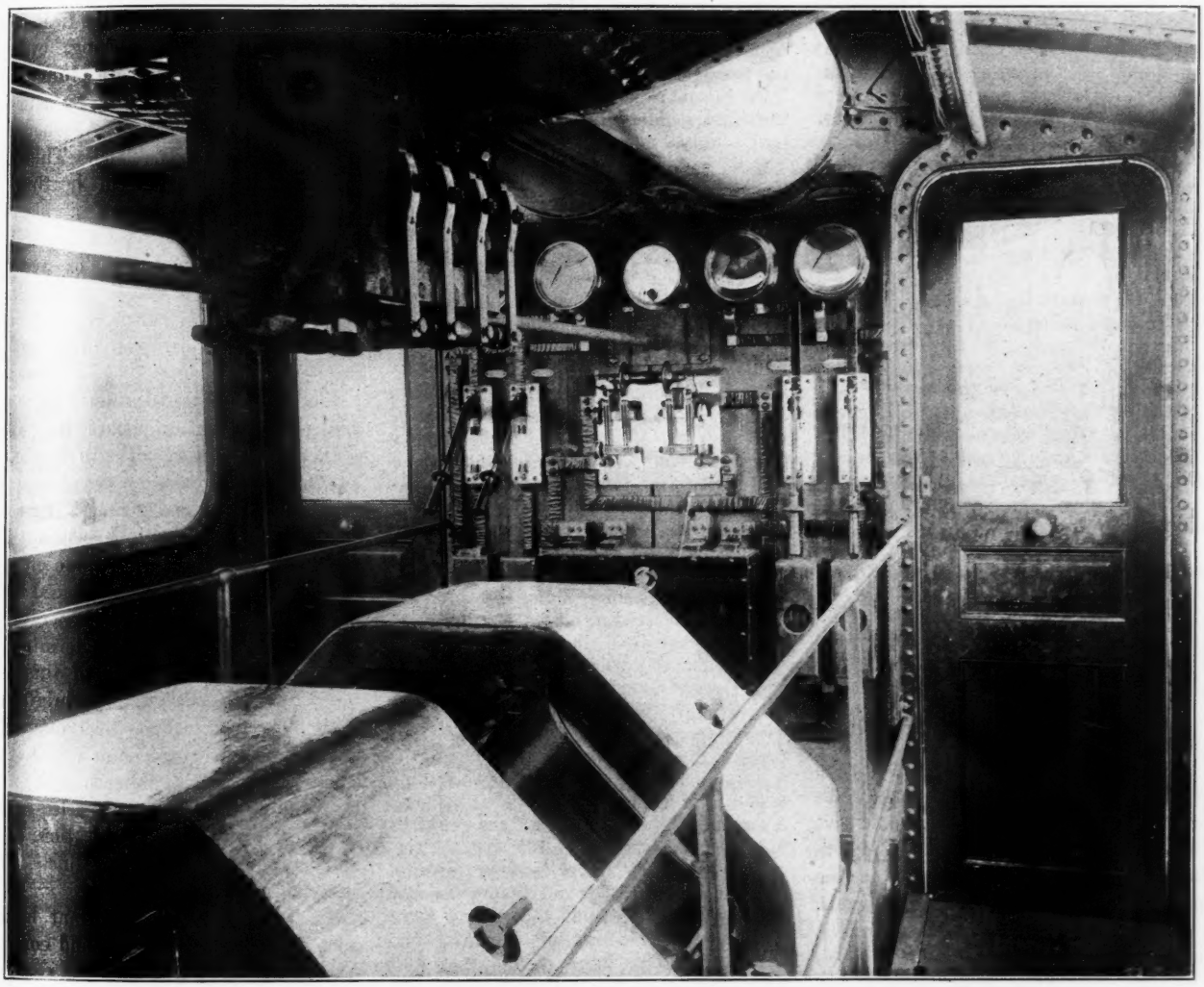
The beautiful control secured is illustrated by the results obtained when applied to moving turrets of battleships. Exhaustive tests of the Ward Leonard system have been made by naval engineers, and it has been proved that this heavy load of about 300 tons, corresponding to a good-sized train, could be started and stopped easily and quickly, and that the guns could be shifted with certainty through an angle corresponding to a

movement of two inches at a range of 1,000 yards. This movement is less than the angle included by the cross-hairs of the sighting telescope.

The reliability of this system of operation has not been put to practical test on railroads, but elevators have been operating by this means for six or eight years with certainty and practically no cost for repairs. The system has also been found very reliable for operating large coal elevators.

The objection which is raised against the system is the increased cost of locomotives, as each of these must carry, in addition to its driving motors, a motor-generator set. The system, however, does away with substations containing moving machinery, and requires but a single trolley wire. Since the line is fed by alternating currents, there will be no effects due to electrolysis.

A multiple-unit system has recently been patented by Mr. Leonard, which is applicable to his locomotives and which is exceedingly simple, requiring, as it does, but three or, at the most, four wires along the train. In this, locomotives are distributed throughout the train, and the generators on these locomotives are excited by the single exciter on the locomotive from which the train is operated. The exciting currents for the generators are carried through the train wires mentioned above. Since all the generators are excited from one machine, the field currents will be the same and all of the motors will be operating under the same conditions, therefore doing the same amount of work.



INTERIOR VIEW, ELECTRIC LOCOMOTIVE CONSTRUCTED BY THE SOCIÉTÉ ANONYME DE LOCOMOTION ELECTRIQUE, PARIS.

It is probably not generally known that the moving sidewalks at the Paris Exposition of 1900 were operated on a modified Ward Leonard system. These were about four miles long, and had the motors distributed at intervals representing somewhat the conditions which are advocated by Mr. Leonard. After discouraging results, when trying to start in other ways, the motors were connected directly to the mains, and the latter directly to the generators. To start the platform, all switches were closed and a resistance introduced into the generator field, the current for exciting being drawn from a separate machine. The voltage of the generator was then gradually brought up and the platform started easily and without undue strain on the engines after sufficient current had been produced to develop the necessary starting torque. In this particular instance the motors used were series machines, but this is a minor difference and immaterial in the operation of the system.

The Ward Leonard system has been put to practical test by the Société Anonyme Locomotion Electrique, which has constructed two locomotives and put these to very thorough tests on an experimental track near Paris. The accompanying illustrations show an exterior and interior view of one of these locomotives as it stood in August, 1900. The third-rail system was used, with low voltages, as the operation of the locomotive could be ascertained in this way. The interior view shows the motor-generator set and the controlling mechanisms, indicating instruments, etc. The operation of these machines was so satisfactory that the

company has secured a license for the system.

Early this year, the Oerlikon Company, of Switzerland, decided to equip a road by the Ward Leonard system, with power stations seventy-five miles apart. A locomotive with a capacity of 700 horsepower and a total weight of forty-four tons is now being constructed. Alternating currents will be distributed at 15,000 volts. Trains weighing 250 tons will be hauled at speeds of forty kilometres on a grade of one per cent, taking about 565 kilowatts. This, at 14,000 volts, calls for a line current of only forty-five amperes. The system has received a good deal of attention from English engineers, and its many excellent features pointed out. It enables the train to be got under way in a minimum time, with less demand on the generating station than when a train is running at full speed. By the use of this system, the cost of the transmission line can be kept very low, and this will compensate for the increased cost of the locomotives.

Summing up, the chief advantages of the Ward Leonard system apparently are: For passenger service, the trains can be started quickly and without discomfort to the passengers. For freight service, the maximum starting effect is secured with little strain on the station.

The length of trains is limited only by other considerations, as locomotives can be scattered throughout the train and are controlled easily from one point. The controlling mechanism does not break circuits carrying heavy currents. The difficulty of handling heavy currents by means of a controller has proved a stumbling block in many attempts at heavy railway work.

The Speed of Transmission in Telegraphy.

By the speed is meant the number of signals which can be received at the end of a line in a given time. This number is intimately connected with the study of different effects, and is of interest in rapid telegraphy. A theoretical consideration of the matter, which considers only the electrical properties of the line, would give results far from true, although these constants play a considerable part in the operation and transmission of signals. Considering the various effects separately, an article in *L'Electricien*, Paris, shows that it is well known from Hertz's work that the speed of the transmission of electricity is about 300,000 kilometres per second, so that the time required to transmit an electrical impulse over a wire 1,000 kilometres long would be about 0.003 of a second. Although this time is small, it can not be neglected in rapid working. The capacity of the line retards the passage of a wave, as it becomes necessary to charge the conductor. Furthermore, although the circuit is broken quickly, it does not die out as rapidly. The time required to bring the current to its maximum value depends upon the product of the capacity of the line and its resistance. Although the line would require an infinite time theoretically to assume its final charge, practically, the current will reach nine-tenths of its value in a time represented by one-third of the product of its capacity into its resistance. This product is called the constant of the line. Considering a signal sent out from a source of constant potential at the transmitting end of the line, it is seen that this will be delayed at the receiving end by the time required for the propagation of the current. The establishment of the maximum value of the current will be further delayed by the capacity and resistance of the line, these causing the current to rise gradually to its final value. There will be a further delay, caused by the inductance of the receiving apparatus. The speed of the propagation of a signal therefore depends upon four effects—the time required for the passage of the electrical wave over the line; the retardation due to the receiver; the time required for the current to attain a value sufficient to operate the receiver, and the time required for the mechanical operation of the receiving apparatus. Applying these considerations to a practical example, with a line of copper wire having a length of 1,000 kilometres and a diameter of three millimetres, the time required for the propagation of the wave will be 0.003 of a second. The retardation due to self-induction is taken from experience as 0.008 of a second. The time required to establish a current sufficient to operate a receiver will be 0.005 of a second, while practice has shown that another 0.005 of a second will be required for the mechanical movement of the receiver. This gives a total of 0.021 of a second. The speed of transmission will not be affected by certain of these effects under ordinary conditions, because after the first signal has been received all succeeding signals will be retarded by the same time. If, on the contrary, the line is used alternately for sending messages to different stations, all these effects must be considered. To check these theoretical considerations, two practical cases are examined, where the messages are sent by the Baudot sextuple system. It has been found that the maximum speed at which these lines could be operated corresponds to 105 distinct signals per second. Applying the formula to these lines, it is found that a time of about 0.005 of a second is required for a mechanical movement of the receiving apparatus. This figure agrees very well with that found by an experiment. The time required to transmit the wave over the wire, and the delay caused by the inductance of the receiving apparatus, do not affect the speed of transmission. The results of these considerations may be summed up in a formula consisting of two factors, one of which depends upon the time required to operate the receiving apparatus, and the other upon the capacity and resistance of the line. In the case of a Paris-Marseilles line, it is shown that 0.22 of a second is required for each signal. This figure has been confirmed in practice.

ON A REMARKABLE PHENOMENON IN GASES SUBMITTED TO VERY HIGH TEMPERATURES.

BY DR. JOHN TROWBRIDGE.

For several years I have been studying the spectra of gases produced by powerful discharges from condensers charged by a storage battery of from 10,000 to 20,000 cells. A year ago I reached a limit in this study, for the glass vessels containing the gases volatilized under the effect of the discharges, and after one or two discharges cracked under the effect of the great heat.

I was fortunate during the past summer to obtain in London suitable vessels made of quartz, which can be heated to a white heat without cracking, even if, while at this heat, they are plunged into cold water. They are made by a process invented by Professor W. A. Shenstone, of Clifton College, England. This process consists essentially in heating the quartz for some time in a platinum crucible in a muffle furnace and afterward heating the fragments in the oxyhydrogen flame. From the fragments, sticks of limpid quartz are thus prepared, from which glass vessels, even of large size, can be made.

For my purpose Geissler tubes were made—four or five inches long—with a capillary portion of two inches in length. In this capillary the electric discharges form the most intense light that has ever been studied, I believe, in a laboratory. In its photographic effect, it is at least four times that produced by the same amount of electrical energy discharged between magnesium terminals.

The result of my study of this light reveals the presence of both bright and dark lines in the ultra-violet portion of the spectrum of hydrogen or water vapor. The dark lines have never been seen before. They are due to a selective reversibility, or selective solarization, of the photographic images of the lines of the gas.

This result has an important bearing upon theories of the nature and constitution of the stars, and upon the character of the sun's spectrum. There are probably dark, gaseous lines also in the visible portion of the sun's spectrum. To the eye, this intense light of hydrogen appears to give a continuous spectrum with no bright lines. Photography, however, reveals many bright and dark lines in the ultra-violet. A new field in spectrum analysis thus appears to be opened.

Jefferson Physical Laboratory,
Harvard University.

November 7.

Electrically Operated Food Plant at Niagara Falls.

By Frank C. Perkins.

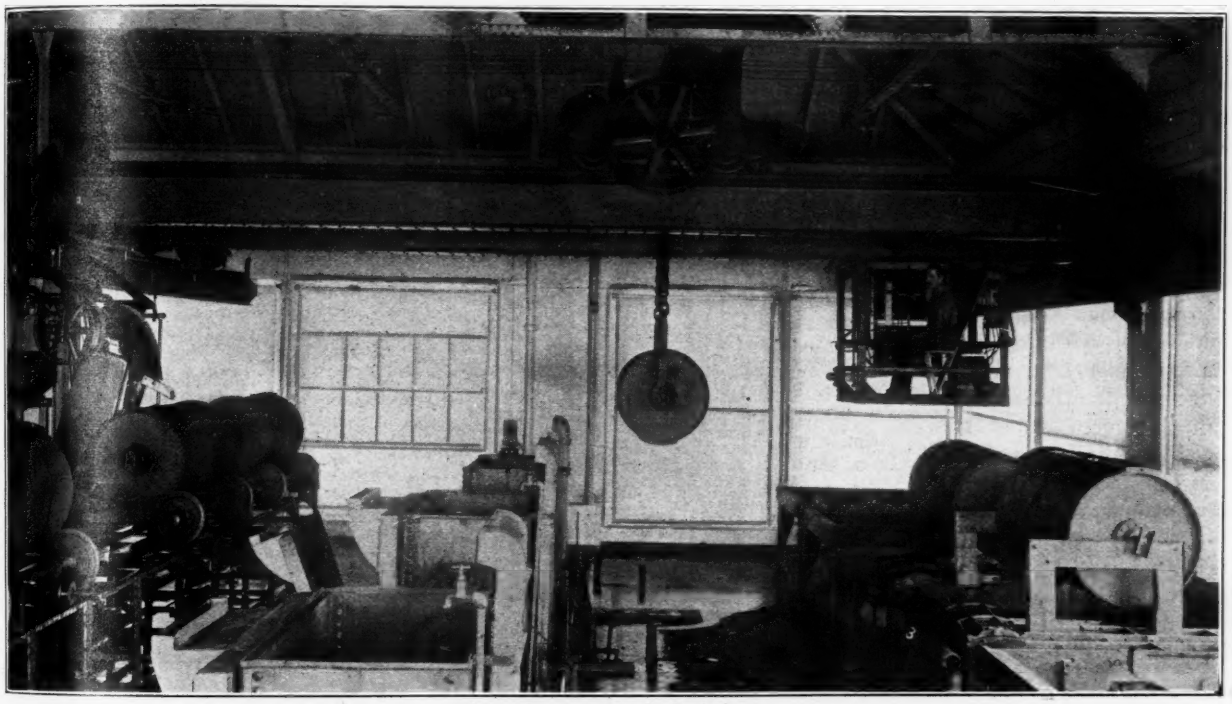
MANY of the most progressive factories throughout the country are at present utilizing electricity for supplying the necessary lighting as well as furnishing the required power for the operation of the various machines. At Niagara Falls the Natural Food plant is equipped with electrically operated apparatus and is up to date in every particular.

Both alternating and continuous currents are utilized for operating the various shredding machines, elevators, tools, blowers and other machinery. A storage battery is provided for operating an electric railway in miniature, from the kitchen to the dining-room, as well as for use in the private telephone system and signals.

The electric kitchen of this plant is equipped with the latest electric cooking apparatus and is used for preparing the numerous dishes with the product of the factory for demonstration purposes and for the employés. The balcony which surrounds the main floor is provided with seats for a large number of guests, and a miniature electric railway is fully equipped with trains, stations, guards and electric switches, and is used for serving the visitors with tasty luncheons. The numerous guests are seated at small white tables, on each of which travels a small electric car, and a menu card is provided at a small desk at the table with electric buttons, by means of which the order is given. The tiny car automatically travels to the electric kitchen on the main track, and after being supplied with the necessary order returns automatically and is shifted from the main track to the guest to whom the order belongs. A neatly arranged block system is arranged which prevents any disaster or accident, and the car moves back automatically to the station from which it started, with the luncheon attractively served, the car itself serving as a neat table for the use of the visitors.

The electric cooking equipment is most complete, and a dining-room is provided for the women operatives. Tasty dishes of various kinds are served to the employés, while a pleasant library and parlor is provided with comfortable chairs, a piano and an abundance of reading matter. All employés and visitors are frequently invited to a well-appointed lecture room which is provided with electric stereopticon, as well as both direct and alternating current, for demonstration purposes. The most approved cooking utensils, chafing-dishes, coffee and teapots and other utensils are used for the demonstration of electric cooking.

The new wheel-pit and power-house of the Niagara Falls Power Company are fast nearing completion, when the total output of electrical energy will be increased to 100,000 horse-power, and a number of important manufacturing plants will soon be established along the Niagara Frontier. One of the important electrically operated factories at Niagara Falls is that of the Natural Food Company, which uses electrical power for operating the entire plant. The two-phase alternating current is reduced in potential from 2,200 volts to 250 volts, and 400 volts in two transformer rooms at the Natural Food plant, known as the east and west transformer rooms. The total power required for operating this factory is more than 5,000 horse-power, and is distributed throughout the building for lighting both incandescent and arc lights as well as more than 100 motors. The current is reduced in potential from 2,200 volts to 110 volts for lighting purposes, and to 440 volts for use on the motor circuits which supply motors ranging from one horse-power to fifty horse-



THE COOKING ROOM, WHERE THE WHEAT IS WASHED AND PLACED IN THE LARGE TUMBLERS, AND LOWERED INTO KETTLES FOR COOKING.

power, and aggregating more than 1,000 horse-power.

The step-down static transformers have each a capacity of seventy-five kilowatts, lowering the potential to 183 volts, the two-phase current being changed to a direct current by 150-kilowatt Westinghouse rotary converters which operate at the speed of 500 revolutions per minute.

The circuit current is used for operating four electric elevators, as well as numerous fans and the electric stereopticon in the lecture room. A completely equipped machine shop is provided with electrically driven lathes, shapers, grinders and planers, and all of the necessary repairs are made within the building. A hot-air fan system is utilized for heating and ventilating, various blowers being operated by both electricity and steam. One engine of 100 horse-power capacity drives two blowers sixteen feet in diameter, installed by the American Blower Company, providing a complete change of air in fifteen minutes. Electric motors of ten-horse-power capacity with silent chain drive operate four blowers for evaporating purposes.

The second or west transformer room is similarly equipped to that of the east transformer room, except that a motor-generator is provided for charging storage batteries supplying current for operating the miniature electric railway which is utilized between the electric kitchen an the electric dining-room. The electric cooking transformers have each a capacity of 140 kilowatts, reducing the pressure from 2,200 volts to 80 or 120 volts as desired, the potential being controlled by regulators in the primary. Two of the four electric Otis elevators are operated by fifty-horse-power motors, and are used for passenger service, while the two remaining freight elevators are driven by twenty-five-horse-power motors.

This photograph (Fig. 1) is made in the cooking room where the wheat is washed and put in the large tumblers illustrated, and lowered into the kettles which are steam-jacketed, where it is cooked for thirty minutes before passing to the floor below.

These tumblers, filled with wheat, are handled by an electric crane built especially for the company by the Case Manufacturing Company, Columbus, Ohio. This crane has a capacity of 2,000 pounds and thirty-one-foot span. It is operated by three induction motors of 2.4 horse-power each, built especially for this work by the Westinghouse Electric and Manufacturing Company. They are operated on a 440-volt, 25-cycle current furnished by the Niagara Falls Power Company.

There are two cooking rooms, one at each end of the large building. Both rooms have the same equipment.

The cranes are operated by double-throw switches supplied by the Crouse-Hinds Electric Company, of Syracuse, N. Y.

The sealing machines are on the fifth floor of the main conservatory at the east end. In these machines the cartons enclosing the finished product are sealed and put in cases. These machines are driven by two three-horse-power induction motors located on the ceiling eighty feet away from the operating switches which are located at the operating end of the machines. A carton elevator, also driven by a small motor, brings the cartons up from the second floor or main shredding floor up to this floor. They are transferred from this carton elevator to the sealing machine.

The electric elevators are placed entirely over the hatchways, thus being above the sixth floor of the main building. These consist essentially of an Eickmeyer motor direct-connected to the worm shaft of the elevator. This motor is compound wound and is made to operate on a 220-volt direct current supplied from a 150-kilowatt rotary converter located in the east transformer room.

This converter is also Westinghouse type, and was furnished and installed complete with switchboards and static transformers. The static transformers step down the 2,200-volt, 25-cycle current to 186 volts, at which pressure it is brought to the collecting rings on the alternating-current end of the rotary.

The elevator is the latest improved Otis double-screw type machine. This is driven through two worm gears, which mesh into each other and the worm shaft contains two worms cut in opposite directions, so that by engaging the two worm gears, which are in turn meshed together, the necessity of a thrust bearing is obviated, which is the greatest difficulty in this form of an elevator. At this point is also placed the controlling device for the elevator, which is the Otis company's latest magnet form. These elevators are fitted with an electromagnetic brake. The elevator has all the latest forms of safety devices and is one of the most perfect of this company's machines.

There are four of these elevators installed in the plant. Two of them are made for 4,800 pounds at 200 feet per

FIG. 2.—THE CLEANING ROOM, NATURAL FOOD COMPANY, NIAGARA FALLS, N. Y.

minute and the other two for 4,800 pounds at 100 feet per minute.

In this room is also an induction motor which is used for driving one of the conveyors.

The accompanying photograph, Fig. 2,

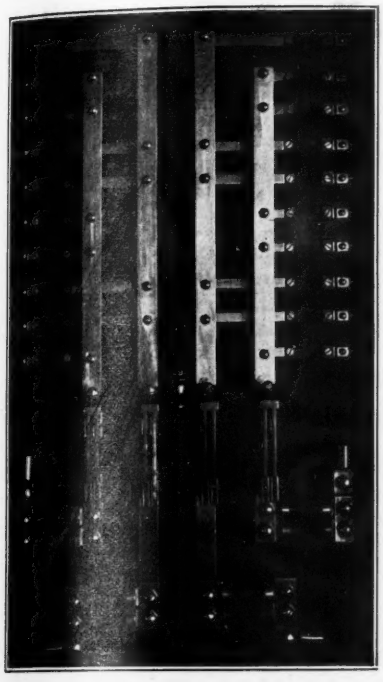


Fig. 3.—One of the Power Panels, Natural Food Company, Niagara Falls, N. Y.

was made in the cleaning room, where the wheat passes through the different air-cleaning machines. This room is driven by two twenty-horse-power and one seven and one-half-horse-power Westinghouse induction motors, twenty-five cycles, 440 volts.

The illustration shows the cast-iron subbase for the autostarters, and the circuit-breakers located on the sides thereof. The two twenty-horse-power motors are belted to a jack-shaft, which, in turn, is belted to the main driving shaft of the cleaning room.

The cleaning machinery has a capacity of 3,000 bushels of wheat per day.

The switch at the left is used to operate a seven and one-half-horse-power motor which is located on the platform in the top of the room, for driving the large separator and elevator.

It will be noted that no autostarters are used with this size machine. Autostarters were adopted for the ten-horse-power-motor size and above. All motors below ten horse-power are operated by a switch.

Fig. 3 illustrates the front of one of the power panels, showing the four leads brought from the wire shaft through D. & W. fuses to the two branch switches, which are in turn fused with D. & W. fuses. The power boxes are furnished by the Crouse-Hinds Electrical Company, of Syracuse, N. Y., and are made of blue Vermont marble enclosed in an iron frame lined with asbestos.

The accompanying illustration, Fig. 4, is a special panel box at the Natural Food plant for controlling 2,000 amperes used in a large model electric kitchen in the plant. This panel board distributes the twenty-five-cycle current at 120 volts. By referring to the illustration, these four terminals can be easily determined leading to the four different bus-bars, which in turn are connected to the different leads by D. & W. enclosed fuses. These fuses are not in place, but the clips are easily discernible.

The Cauvery Power Transmission.

The Cauvery Falls, on the river of the same name in India, have been developed by the Mysore Government, and the power is now transmitted to the Kolar gold fields, where it is used in the mines. The distance of transmission is ninety-two miles. The power, when delivered on the gold fields, is used for two purposes—crushing the gold quartz and driving the air compressors which operate the tools in the mines. In each case the labor arrangements are such that there is a continuous load for practically the whole twenty-four hours. The only variable loads are caused by the motors driving

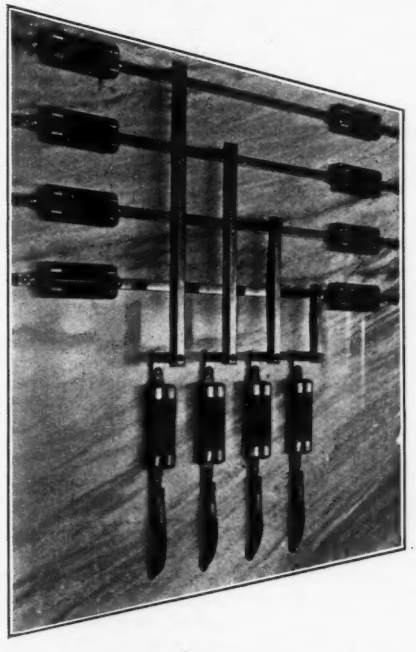


Fig. 4.—Special Panel Board, Natural Food Company, Niagara Falls, N. Y.

five hoists, and these form but a small portion of the total. The motors now installed vary from 5 to 400 horse-power, averaging about 130 horse-power. As a rule, induction motors are used, but some of the larger units are of the synchronous type. This enables the lagging currents in the line to be reduced. The Cauvery River is one of the largest in the southern part of India, draining over 6,000 square miles before it reaches the falls. The headworks enable the entire flow of water to be utilized when necessary. The canal for conducting the water to the power-house is three and one-third miles long, and is divided into two parts by a longitudinal central wall, so that either part can be cleaned without interrupting the station. From the fall bay the water is carried down to the house at the foot of the cliff, with a vertical drop of 400 feet. The length of the pipes is 930 feet, and they are forty-five inches in diameter at the upper end and thirty-six inches at the bottom. Within the power-house are six Pelton wheels, supplied by Escher, Wyss & Company, of Zurich, Switzerland, which are connected directly to six alternators built by the General Electric Company, of Schenectady, N. Y. Each turbine has an output of 1,250 horse-power. They are sixty inches in diameter, with an efficiency of seventy-five per cent at full load and seventy per cent at half load. This high efficiency is secured by a new type of governor, which reduces the size of the orifice through which the water passes, instead of deflecting it, as is generally done. The alternators have an output of 720 kilowatts, at 200 volts, and their normal speed is 300 revolutions per minute. The maximum output of the station can be supplied by five of the alternators, leaving the sixth as a reserve. The situation of the power-house is very unhealthy, and for this reason as much of the equipment as possible was installed at the top of the cliff. At this point is placed the transformer house, where the pressure is raised from 2,200 volts to 30,000 volts for transmission to twelve alternators of 400 kilowatts each, air-cooled by an electrically driven air-blower. Two distinct pole lines are provided, sixty feet apart, upon which the three wires of No. 0 B. & S. gauge are supported three feet four inches apart. The poles are in two sections, the lower half being of steel, thirteen feet in length, and the upper half of wood, seventeen feet in length, and seven inches in diameter. Crossing the river, the copper wire is replaced by silicon bronze. The longest span which had to be erected was 525 feet. At the gold fields the pressure is reduced to 2,300 volts, at which it is distributed. The large motors use this pressure directly, but it is further reduced to 220 volts wherever small motors are supplied. The line was calculated for an approximate loss of twenty per cent from generators to motors. Many problems were met in the erection of this plant, among these being the difficulty of transporting the heavy machinery through this rough country, and also the unhealthy climate.

THE FUTURE OF THE TELEPHONE IN THE UNITED KINGDOM.*

BY J. E. KINGSBURY.

To the members of the British Association the telephone and its applications can not fail to be of interest, for they must ever recall with pride that it was at the Glasgow meeting of the association in 1876 that Alexander Graham Bell's invention was first introduced into this country by Sir William Thomson of that time and the Lord Kelvin of this. The telephone then was a scientific marvel, and attention was centered on its improvement as a talking instrument. Some of its possibilities were foreshadowed, but its principal application was not foreseen. At the meeting of the association at Sheffield, in 1879, an exchange was shown in operation coincident with the opening in London of public telephone exchanges. From that time the science of the telephone has been the science of telephonic intercommunication.

Like all the more recent practical applications of scientific principles it is in itself a composite art calling to its aid not only acoustics and electricity, but of late years more particularly the heavier branches of mechanics and engineering, since the modern telephone exchange has anticipated the power schemes by producing at one centre the electrical energy required to signal and to talk between thousands of stations over lines mostly placed underground at a considerable cost and requiring much engineering skill. Any one of the elements of this composite art would afford interesting subjects for discussion. But they have been and will be dealt with elsewhere and at other times, and will be only very casually touched upon in this paper. The future progress of the telephone in the United Kingdom does not depend upon scientific developments, but upon common sense. In this it does not differ from most engineering questions, for I take it that engineering is a means to an end—that an engineer would derive little satisfaction from the construction of a bridge, however beautiful its proportions, if the approaches rendered it of no utility.

There are at the present time some impediments on the approaches which need removal. They are of a political, economical and social nature, and they exist, as I think, largely on account of the lack of public recognition of the peculiarities which differentiate a telephone exchange system from other works of practical utility. It is my object in this paper to attempt to remove some of the popular misunderstandings which undoubtedly exist, and by placing before you some of the features upon which telephone service depends draw some conclusions as to its future. You will, of course, be prepared for a considerable dip into the past and some reference to the present before the future is reached.

It is necessary to bear in mind that in 1870 various companies undertaking the transmission of telegrams were acquired by the state, and the work which they undertook was combined with that of the Post Office. The Act of 1869 extinguished competition in telegraphs, and conferred on the Postmaster-General the exclusive privilege of transmitting telegrams. The Post Office had been carrying on this business for six years when the telephone was invented. Its development and application to purposes of profit in the United Kingdom took another three years, so that telephone exchange companies began operations in London in 1879. The Post Office claimed that the service rendered by the telephone companies was an infringement of the powers conferred on the state by the Telegraph Act of 1869. The telephone companies contested this claim, but it was decided in favor of the Post Office in the suit of the Attorney-General *vs.* the Edison Telephone Company, of London (Ltd.), tried before Mr. Baron Pollock and Mr. Justice Stephen, in 1880.

The reasonableness of the decision is even now sometimes questioned, mainly because the act was passed in 1869 and the telephone invented only in 1876. But distinction needs to be drawn between (1) a service which the state reserved to itself the sole right of undertaking and (2) improvements in apparatus for, or in the means of carrying out, that service.

The service reserved by the state was the transmission of telegrams, and in Mr. Justice Stephen's very careful judgment he shows that within the definition of the Act of 1869, "any apparatus for transmitting messages by electric signals is a telegraph whether a wire is used or not, and that any apparatus of which a wire used for telegraphic communication is an essential part is a telegraph whether the communication is made by electricity or not." Thus the telephone was only an improvement in, or an accessory to, the service of which the state held a monopoly.

Counsel for the company gave notice of appeal, and the Attorney-General, on behalf of the Crown, stated "that, of course, the Postmaster-General is fully alive to the advantages derived by the public from telephonic communication, and whatever result this litigation may lead to care will be taken in the interests of the revenue, and also in the interest of the public, that nothing shall be done to stop telephonic communication so far as it is required by the public." This statement foreshadowed the policy which the government had considered it advisable to pursue—*viz.*, to work the telephone exchanges through the medium of private organizations or public companies acting under license. Licenses were issued for a period of thirty-one years conditional on payment of ten per cent of the gross receipts. An indication of the government's intention to resume the working of the system at some period is given by a condition of the license that the government was to have the right to purchase the licensee's business at septennial periods upon giving six months' notice, and subject to arbitration in event of disagreement on price. The first licenses limited communication to four or five miles from a defined centre, the state providing trunk lines between the areas. The limitation was found to be inconvenient. It was removed in 1884, and trunk wires between towns were erected by the companies. In 1896 the trunk wires were purchased by the Post Office, and the companies' work limited to "telephone areas" based on the requirements of localities.

Efforts have been made to obtain a reduction in the Post Office royalty, which has been denounced at various times and has been complained of as a tax on communication, as the newspaper stamp was denounced as a tax on knowledge. But even the sufferers by it did not universally condemn that objectionable tax, for Addison, in the *Spectator* of the day preceding the application of the stamp, intimated that he would glory in contributing his utmost to the public weal, and remarked that, "It is a received maxim that no honest man should enrich himself by methods that are prejudicial to the community in which he lives, and by the same rule I think we may pronounce the person to deserve well of his countrymen whose labors bring more into the public coffers than into his own pocket." In this mildly ironical way did Addison convey the information that of the price paid by the purchaser one-half went into the public coffers. The telephone royalty is more moderate, and it can not be said that the labors of the telephone company put more into the treasury than is distributed among its shareholders, but the amount is a substantial one, for during the last ten years the company has paid in Post Office royalty £916,000 in round figures. For the past year the royalty was about £150,000. The royalty is a part of that protection of the revenues of the state to which the Attorney-General referred, and so far as the companies are concerned it may be regarded as a payment by means of which they are enabled to earn dividends, since, without a license, it would not be possible for them to undertake the business at all

The Post Office not only reserved the right to compete, but in some places actually did compete, and in others granted licenses freely to competing companies. The inference to be drawn from its attitude is that it was careful not to create monopoly outside itself, regarded freedom of action as tending to the public benefit, and was satisfied to let ordinary laws work out the solution of the problem so long as its sovereign rights were maintained and its tribute paid. The service was a new one; there had been no previous experience of its working, and no reasonable forecast could be made.

The competition which existed between the Bell company and the Edison company in 1879 ended by the amalgamation of the two into the United Telephone Company, in 1880, before any considerable work had been done, and resulted rather from the advantage of combining patent rights than extinguishing any extensive business

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competition. But, as a subscriber to the Edison company, I am able to bear witness to the advantage of the increased capacity of communication which resulted from the amalgamation, small as that would seem now. Shortly after the amalgamation a company called the London and Globe Telephone Company established an exchange in London, proposing to charge a reduced rental of £12 per annum instead of £20, the rate then ruling. The company discontinued its operations after a few hundred subscribers had been connected, because it was unable to obtain instruments free of the Edison patent. As a subscriber to the London and Globe company, I can also speak from experience of the advantage of the reduction in telephone subscriptions which resulted from the cessation of a duplicate service. The other principal competitive exchanges during the patent era were at Dundee and Sheffield, and in anticipation of the expiry of the patents an exchange was started in Manchester by the Mutual company.

The Dundee company was purchased by the National Telephone Company at an early stage in its career; the Sheffield company was eventually absorbed, and the Mutual company lived but a comparatively short period.

The popular view of these amalgamations is well known. The real reason has been overlooked. Before formulating it, I will ask you to consider what a telephonic conversation is, and how it is obtained.

Let me make a comparison between telephone exchange service with which we have been familiar for a little more than twenty years and other services which have existed for much longer periods. There are no longer any competing telegraphs in England, but let us suppose there are. I desire to send a telegram to any town. I can take my choice of lines. There is no restriction whatever on the delivery of my message to any inhabitant of that town I may desire to communicate with. In the same way I may take advantage of railway competition by choosing the cheapest or quickest route, or I may prefer to take the longest or most expensive route on account of its natural beauties. What would be thought of the advantages of a railway competition from London to Liverpool if the latter city were divided into two portions, and it were ordained that for a destination on one side of St. George's Hall it would be necessary to travel by the North Western and for a destination on the other side by the Midland Railway. Let us suppose the issue of season tickets. With one season ticket a passenger would be able to reach one-half of Liverpool. If he desired to reach the other half as well he would require two season tickets, and would need to take a different route for either destination. By the division I do not mean a policeman outside the station to direct your cabman by a given street, which order he can evade at the next turning. You must please to imagine an impenetrable barrier. You regard this undoubtedly as a preposterous proposition, but it is exactly analogous to the conditions prevailing under competition in telephony. There are a restricted number of possible correspondents for distinct services or double season tickets if you wish to enlarge your area of communication to the fullest possible extent. The reason why competing services have ceased in the past, is because the absurdity of such a situation becomes obvious when put in practice.

Let us see how the subscribers of the lapsed companies fared in the combinations which have been made. The Dundee company, at the time of the amalgamation, had 332 subscribers; 152 of these subscribers belonged to both companies, and thus had two season tickets. Each subscriber to the local company paid £5 10s. per annum. He thus paid 3.975 pence per annum each for the opportunity of communicating with 332 subscribers. On amalgamation the subscriptions of the 152 were slightly reduced and of the 180 largely increased, but the annual cost of the right to speak with each other subscriber was reduced from 3.975 pence to 2.919 pence, and with the increase in subscribers this reduction was continually growing in favor of the original subscribers. In addition to the larger number of possible correspondents in their own locality, the amalgamation gave the subscribers to the local company access to other localities, thus adding considerably to the value of the telephone to them. The influence of a widespread "telephone net"—to adopt a Continental expression—may be compared with the force of gravity. Sooner or later the smaller local body if it do not evaporate altogether must be attracted to the larger body. And if the repellent force natural to competitors should retard unduly the operation of this attractive force, then the latter will inevitably be assisted by some superior power in the interest of the public weal, for it must be remembered that the proprietors of exchanges and the subscribers thereto are not the only people concerned. The general public experience some of the drawbacks of this competition. As an example, I may cite an instance from Scandinavia—a part of the world frequently referred to in connection with the advantages of competition in telephony. About the time of the competitive services in Dundee, rival companies were giving the citizens of Christiana the same advantages, when (August 20, 1884) the "municipal council resolved, in accordance with the proposal of the executive committee, to notify the International Bell Telephone Company, and the Christiana Telephone Association, that after two weeks they shall not be allowed to run new telephone lines over the public streets, squares, etc., and the council appointed Messrs. Birch, Reichenwald, Anderson and Christopherson to aid the executive committee in negotiating with the telephone companies an amalgamation into a single company." The round-table conference succeeded in its efforts, the competition ceased, the number of subscribers grew rapidly, and the exchange has since been acquired by the government.

The experience of Dundee was not repeated in the United Kingdom for a number of years, because the National Telephone Company was protected by patent rights. On the expiry of the patents a number of public-spirited citizens of Manchester combined to remove from their town the stigma of being dependent on a telephonic monopoly, and to demonstrate to their predecessors of Dundee the iniquity of being bought up at a profit, they formed the Mutual Telephone Company, of Manchester.

The Mutual company was in due course acquired by the National company. At the time of the amalgamation 492 of the 1,349 subscribers of the Mutual company also subscribed to the other company. The ratio of subscription to number of subscribers—that is, the cost of the opportunity to communicate—was 1.320 pence per subscriber per annum. On amalgamation it was reduced to 0.567 penny.

In the parliamentary committee report of 1895 it is shown that the average payments of the Mutual subscribers were £7 8s. 6d. per annum. The average rate of the other company is not given. The normal rate was £10. The average would probably be slightly higher. The total payments by the people of Manchester before and after amalgamation were, approximately, as follows:

Before amalgamation—						
National.....	3,374 at £10	0	0	....	£33,740
Mutual.....	1,349 at	7	8	6	....	10,016
	4,723					£43,756
After amalgamation—						
Combined subscribers.	4 723					
Less duplicate.....	492					
	4.231 at £10	0	0	....	£42,310

While the latter total is lower, yet in the absence of definite information as to the National company's average the figures must not be taken as more than an indication that, to the then existing subscribers, there was no very material change in the total cost of the service. But this, even if admitted, does not go far with the advocates of competition. The contention is that the lower rate was a paying rate, and that all subsequent subscribers have been overcharged by reason of the absence of competition.

The claim that the lower rate was a paying rate is based on the assertion that, during the existence of the competing companies, they were able to make both ends meet. I neither confirm nor combat the assertion, but I wish to correct an impression which is very natural to the mercantile mind. It is that on the fixed subscription plan every additional subscriber is a monetary gain. A new subscriber adds to the working expenses, in that he not only makes calls himself, but increases the calls of other subscribers. With the growth of the exchange there is an increase in the apparatus or plant used in common, such as junction wires and switchboards, as well as in the number of operators. Hence, with the same class of equipment, the increase in subscribers

leads to a disproportionate increase in cost of plant and working expenses.

The reason why the working costs at the present time are not considerably higher than in earlier years is, because the class of equipment is not the same. Improved appliances have been introduced, additional plant has been erected or old plant reorganized, enabling the work to be done more economically. But these improvements have cost money, and it will at once be seen that upon these early exchanges, which are so often referred to, further expenditure would need to have been made without an increase in revenue, and from this may be seen the importance of making an allowance for depreciation before arriving at the cost of the service. Depreciation in telephone plant must not be confounded simply with the wear and tear of ordinary machinery. Certain portions may be claimed to be practically indestructible in themselves and yet require considerable depreciation allowance. This arises from the changes caused by growth whereby plant is displaced even though capable of continued use. No rule can be laid down for universal application. There are instances of five per cent and of fifteen per cent being allowed, but the medium figure is more general.

As I have said, the real lesson of the amalgamation was never learned. The apparently profitable nature of telephone enterprise, the invariable maintenance of the rates at the higher level, conveyed an impression which has been sedulously fostered that the absorbing telephone companies were simply seeking, in Addison's words, "to enrich themselves by methods that were prejudicial to the community," and Parliament determined by the Act of 1899 to develop, by the aid of the ratepayers, that competition which had so far failed under private enterprise. Two municipalities, Glasgow and Tunbridge Wells, have taken advantage of the permission, and history is repeating itself in its usual way.

The first annual report of the telephone committee of the Glasgow corporation shows that £192,693 14s. 3d. has been spent in equipping an exchange for 5,494 stations. "The stations are subscribed for by 4,697 persons and firms; of these 2,059 have never been telephone subscribers before." This may be taken to mean that all the other subscribers to the municipal exchange are also subscribers to the company's exchange. The average capital expenditure per person or firm (not per station) is £41, but the total expenditure includes work which is very properly undertaken in advance of requirements, and it is a reasonable inference that with a comparatively small additional expenditure sufficient subscribers could be added to reduce materially the above average. It is futile to take only the cost of the useable lines, because there always will be considerable excess. I want only to make a comparison between the useful and the useless expenditure. At a capital outlay of £35 each, 2,059 new subscribers give a useful expenditure of £72,065, and 2,638 a useless expenditure of £92,330. It is not necessary for me to suggest how very much more useful that useful expenditure would have been if it had widened the field of the new subscribers.

In Tunbridge Wells the same results of duplicate subscribers and duplicate subscriptions are found, as was inevitable.

The necessity of anticipating demand, and the supply of plant largely in excess of that actually used, is inherent in telephone service. Conduits in anticipation of cables, cable in anticipation of subscribers, switchboard equipment in excess of immediate requirements; all these necessarily exist in any well-planned exchange.

Every subscriber must bear his proportion of the excess, since, of the revenue obtained from the subscribers, a portion must be devoted to interest on capital. Duplicate the system, and, if they are equally well planned, you double the surplus plant, the capital expenditure therefor, and the subscribers' burden thereon.

Compare the action of these municipalities with the admirable arrangement concluded by the Postmaster-General in London, where every subscriber to the Post Office system is in communication with all the 40,000 subscribers to the previously existing system, so that duplicates are unnecessary and no expenditure is wasted. Competition is a check—a means of preventing undue profit being made by the producer of a commodity or the supplier of a service, and the maintenance of the check requires the continuance of the competition. Technical advocates of competitive telephony realize its temporary character, as will be seen from the published report of the Glasgow engineer recommending another English municipality to undertake competitive service. Dealing with the question of intercommunication between the rival exchanges, he says, "Intercommunication locally from the beginning would render the development of the corporation exchange difficult. . . . But when the corporation's exchange has become larger the conditions will be reversed. . . . On reaching that point, intercommunication might be insisted upon by the corporation with every advantage, for the effect would be to complete the ruin of the opposition system."

It might be argued that it is not the province of a municipality "to complete the ruin" of an enterprise rendering a useful service to any of its ratepayers. It might be suggested that the attempt to destroy sometimes results in being destroyed, but I prefer rather to approach the consideration of municipal telephones in a spirit of sympathy with the municipal ideal, and a realization of the advantages which may sometimes be obtained by collective effort. It is not surprising that, in the absence of an accurate conception of the nature of telephone exchange work, a municipality should be regarded as a suitable body to undertake it. The first idea that occurs to one is that the municipality is the local authority, and yet, as applied to a telephone area, a municipality is only one of several authorities, for while the business centres throughout the kingdom have grown, the municipalities remain to a very large extent simply extensions of the old parochial system, and the extensions have not been carried far enough. The telephone area is the whole district over which the business and social relations to the locality naturally flow, but in its flow it covers numerous ownerships. There is no rivalry equal to the rivalry of neighboring municipalities; there is not a common interest, and in the absence of identical interests there is difficulty in obtaining agreement in policy or on the details of carrying out of a policy.

Agreement may sometimes be obtained as the result of an enthusiasm against what is regarded, rightly or wrongly, as a common foe; it may be continued while the contest lasts. Assume that the ruin of the opposition is completed, will the cohesion continue? Localities change their condition. The fashionable quarter to-day is the business quarter to-morrow. It is the interest of the outlying district to develop its resources. It is the interest of the older and larger municipality—the predominant partner in the telephone area—to retain its prestige, to prevent the development of its rivals. The telephone will be an important factor in such rivalries. Unless it be in independent hands it is easy to foresee a splitting up into smaller units, adding to the confusion, increasing the cost, and generally working to the detriment of the service.

The successful supply of electric light, for example, by municipalities must not be regarded as any criterion of a similar result in the case of telephone exchanges. An electric light station contains a producing plant, the streets carry distributing mains, the service is from the centre outward, and the entire plant from centre to extremities is under one control. A policy may be initiated and enforced without regard to outside considerations. Telephone exchange service, on the other hand, requires that the system should work in with other systems.

Traffic between two places calls for provision for outgoing calls at one exchange and provision for incoming calls at another exchange. Independent views at either exchange are incompatible with successful working. Neighboring municipalities running tramway services might so arrange that there could be no through communication, but the inconvenience occasioned to the passenger would be only that of stepping out of one car into another. The equivalent in telephone service would be the stoppage of communication altogether.

One of the arguments urged for local control is that a large percentage of conversations are local. But compare the value of a local conversation with a long-distance conversation, and it will be seen how important it is that no impediment, either of an engineering or administrative nature, should be placed in the way of such communications. Experience shows an almost inevitable tendency to local or individual preferences, both in the way of

engineering and management, and experience shows also not only the practical difficulties arising from such preferences, but also the greater difficulty of applying a remedy.

It is sometimes assumed that competition is necessary in order to increase the number of subscribers. I will give an example of phenomenal increase without competition. On January 1, 1894, there was about 10,000 stations in New York. On January 1, 1902, there were 72,189 stations in only a portion of the area which was included in the 1894 figures. This considerable increase over the previous progress is attributed to the adoption of a rational system of charging. Up to 1894 there was a "flat rate," the same subscription for large user and small user. In 1894 the message-rate system was applied, with the result that the telephone service has become available to the small user and enormously increased in value to all subscribers by widening the field of communication. This method has also been adopted for the Post Office system in London. It was proposed for adoption some years ago by the National company in Sheffield, but the subscribers rebelled against it.

I have remarked on the extent to which the future has to be anticipated by present expenditure. Each new subscriber involves capital outlay, and new present work invariably includes some margin for future use.

The amount expended during the past five years in adding to the exchange construction and equipment of existing services by similar organizations in the United Kingdom and the United States compare as follows:

	National Telephone Company.	Licensees of American Bell Telephone Company.
1897.....	£460.937	£973.063
1898.....	682.506	1,489.499
1899.....	742.151	3,189.892
1900.....	834 772	4 382.908
1901.....	536.793	4,400.000
	£3 257.159	£14,435.362

In making these comparisons, I wish rather to draw attention to the yearly growth than to compare the totals. In the United States there is considerable growth in new expenditure from year to year. In the United Kingdom there is a fairly gradual increase to 1900, and a decrease for 1901. The difference suggests some reason.

I think it will be found in the fact that in the United States the companies supplying the service have no limit to their existence. In the United Kingdom the company supplying the service dies in 1911, or, to put it more accurately, its right to continue the business dies then. To the Parliamentary Committee of 1898, Mr. Forbes stated that it would be the policy of the company not to embark on new expenditure after 1904, but to maintain its existing system in the best condition till the expiry of the license in 1911. By the Telegraph Act of 1899 it is provided that the license of the National company shall be extended in those areas in which competitive services are stated, the restrictive barrier against intercommunication being gradually broken down. With longer life the hesitation to undertake further expenditure disappears, for the longer period in which returns may be obtained warrants new investment by the company.

Corporations can borrow easily and cheaply. We thus have financially a most anomalous situation. Money can be spent on competitive systems, which are the most wasteful, which give the maximum of inconvenience with the minimum of public benefit, but money can not be spent on developing the existing systems to which additions can be made at a minimum of cost with a maximum of benefit. The future of the telephone depends very much on the present, for equipment for present subscribers includes some provision for future subscribers, and present starvation means future weakness.

The engineering and construction work should be on a scale that provides for considerable growth, and of a kind that will give reasonable expectation of satisfactory results when that growth is attained. On sound financial principles work on such a scale can not be undertaken on the terms of existing licenses. The best that could be expected with a sole tenant is a reasonable surplus on present requirements. The best that can be expected from competitive services with unremunerative rates and short tenure is hand-to-mouth construction work and speedy dilapidations.

The existence of duplicate services designed and operated without regard to one another necessarily means that on the expiry of the licenses it may be found better and cheaper for the state to lay down a new system than to attempt to combine the existing ones. I regard it, however, as extremely doubtful that competitive systems will continue to the end of the license. It seems to me that the result of the competitions now in progress may be easily foretold. I venture the suggestion that competition by municipalities was provided for under a misapprehension of the nature of telephone exchange service, and a misconception of the results, direct or indirect, which might be expected. I venture further the suggestion that those municipalities which have undertaken such competition have done so under a mistaken view of the benefits to be obtained and the cost of obtaining them. But I have too great a faith in public opinion to doubt that as the lessons are brought home the result of existing competition will be the same as previous competitions. Duality will give way to unity as the only reasonable method of conducting the work. Unfortunately, the disadvantages must be apparent and realized before they are regarded, and probably much expenditure will be incurred before the mistake is recognized. In the meantime the future progress in the practical use of the most beautiful and most useful application of science which the past century produced will be seriously impeded.

The "removal of any disadvantages of a public kind which impede the progress of science" is one of the objects of the British Association. The impediment is so much of a public kind as to be fraught with peculiar difficulties, and to involve important considerations of imperial and local politics which are out of our province. I can only hope that the subject may be considered solely from the point of view of the "public weal," and that scientific enquiry may have some share in reaching conclusions. If that be the case, I do not hesitate to express my own belief that the future of the telephone in the United Kingdom will be free from competition, free from the expense and waste of war, developed by the certainty of permanent utility, and cheapened by the economy which unity of control and permanent work will attain.

The Association of German Electrical Engineers.

The tenth annual meeting of this association was recently held at Düsseldorf. The report presented by Mr. Gisbert Kapp, the general secretary, stated that during the past year the cooperation of the association had repeatedly been requisitioned by the German Secretary of State for Home Affairs in connection with the dissemination of information of interest to Teutonic industry. As a rule, the news related to electrical installation projected in other countries and by this means the German firms had been afforded a convenient opportunity to submit tenders for the work. The firms in question were informed of the contracts by circular, which the Secretary of State placed at the disposal of the association for this purpose. After the reading of the report, Professor C. Hartmann, the president, delivered his opening address, in the course of which he stated there were three causes which had helped to bring about the present precarious condition of the electrical industry in Germany. The first was the acquisition by manufacturing firms of concessions for the equipment and operation of electricity works. In exceptional cases that might perhaps be accompanied by success, but in principle it was a chimera to give one's self orders in that manner. Secondly, it led to a depression in prices, because the firms underbid themselves in order that their competitors might not have any advantage; and thirdly, there was a too careless valuation of stocks and insufficient financial provisions, which led to an unpremeditated coloring of the balance-sheets. These evil results showed that the electrical engineer frequently was an inventive constructor and mathematician, but rarely a clever merchant and good accountant. The speaker proceeded to observe that these deficiencies would probably be overcome in the future by the high schools where commercial questions were being taught, as, for instance, at the Leipsic University, the technical schools at Aix la Chapelle, Cologne, and Frankfort-on-the-Maine.

The Atlanta Water and Electric Power Company.

An important southern hydroelectrical power transmission enterprise has recently been projected by eastern capitalists, having for its object the creation of an industrial centre in its immediate vicinity and the possible ultimate development of an electricity supply system in the near-by cities.

The project involves the immediate construction of a concrete dam across the Chattahooche River at the Bull Sluice Shoals, about fifteen miles from Atlanta, Ga., and the erection of a generating station at the dam, containing a complete equipment of turbines, generators, exciters, switchboards and the necessary transforming apparatus for adapting the power to transmission purposes. The ultimate disposition of the power available has not been definitely determined, but for the present the entire output of the plant will be utilized by local manufactories. In the event of a sufficient demand for power at Atlanta, a transmission to the city limits may be installed with a substation at this point where the power will be transformed for local use in mills and factories located near-by.

The plant will have an ultimate capacity of 14,000 horse-power at the generator terminals, of which but 6,000 horse-power will be available at the present time. The remaining 8,000 horse-power will be installed as rapidly as is warranted by the local demands for power.

Steam railroad facilities are at present undergoing improvement for the accommodation of the new industries which, as the result of the power enterprise, will undoubtedly be attracted to this vicinity.

A ten-mile branch of the Southern Railway extends from Chamblee, a few miles north of Atlanta, on the main line, to Roswell, a small manufacturing town located upon the Chattahoochee River, and but a few miles distant from the new water power. A spur track between the power-house and the above branch will furnish transportation facilities for the new industries.

The development of this undertaking involves an expenditure of over one and one-half million dollars, all of which has already been subscribed by the promoting interests comprised in the Atlanta Water and Electric Power Company. The company is incorporated under the laws of Georgia, and is officered by men prominent in hydraulic and electric power enterprises, *viz.*: S. Morgan Smith, York, Pa., president; Forest Adair, Atlanta, Ga., vice-president; J. J. Spaulding, Atlanta, Ga., secretary and treasurer. The board of directors comprises the above gentlemen, together with C. Elmer Smith, of York, Pa., and George C. Smith, of the Westinghouse companies.

The entire hydraulic work, including the erection of dam and power-house and the furnishing of the hydraulic machinery, will be carried out by the S. Morgan Smith Company, of York, Pa.

The electrical work will be designed and executed by Westinghouse, Church, Kerr & Company, engineers and auditors for the Atlanta Water and Electric Power Company. The electrical equipment will be furnished by the Westinghouse Electric and Manufacturing Company, and the entire power installation will represent the most advanced practice of these three well-known engineering concerns.

Previous to the final organization of the power company, a commission of eminent hydraulic engineers was appointed to investigate the proposed location of the dam, together with the possibility of interference with the Atlanta City water supply plant, located a few miles below Bull Sluice Shoals, and to make such recommendations as would ensure the success of the enterprise, and avert such catastrophes as have so often occurred in southern territory within recent years. This commission comprised Mr. John Bogart, engineer of the St. Lawrence Power Company, Massena, N. Y., and Mr. William De La Barre, engineer of the St. Anthony's Falls Power Company, both of whom have been intimately connected with many important hydraulic undertakings in this country. The report of this commission was entirely favorable to the enterprise as originally promoted, and the work is proceeding with all possible speed in entire accordance with its recommendations.

The dam will be constructed of Cyclopean masonry with concrete facings, and will be approximately 1,100 feet in length, 50 feet high and 65 feet wide at the base. The geological formation of the river bed, which is hard gneiss rock, is peculiarly favorable to the hydraulic work, and presents a series of stepped rock surfaces perpendicular to the line of greatest thrust resulting from the pressure of water upon the up-stream face of the dam. Reenforcement of the toe of the dam against weakening by excessive abrasion will be accomplished by a row of steel rails bent to conform to the proper radius and embedded flush with concrete face of the toe. During periods of excessive drought, for the purpose of augmenting the natural reservoir capacity, flash boards will be used. These will be so constructed that in the event of the hydraulic head exceeding a predetermined limit during freshets the excess water will be released, thus relieving the dam from dangerous pressure and preventing unnecessary flooding of the reservoir area above the dam.

The construction of the dam will be accomplished by the aid of overhead cableways suspended between anchorages upon the opposite river banks. Three of these will be used for the purpose of facilitating the work to the greatest possible extent, and avoiding the delays and interferences due to high water or freshets. All rock used will be obtained in the immediate vicinity of the dam, and the entire work will be pushed to an early completion—possibly within eighteen months.

At each end of the dam will be located a concrete bulkhead, each extending ten feet above the crest of the dam proper, into one of which are anchored the turbine penstocks. The power-house will be located immediately in the rear of the main bulkhead and built upon the river bed. Seven steel penstocks, each twelve feet in diameter, extend from their anchorage in the base of the bulkheads to the wheel casings, a distance of fifty feet. These penstocks will be controlled by vertical sliding headgates operated through gearing from the crest of the bulkhead and protected by steel trash tracks, provision for repairs being made by a series of steel frames for stop-logs, should these be necessary. Anchored sluiceways at the base of the bulkhead will be provided for taking care of water during construction of the dam.

The turbines are of the horizontal twin inward flow type, manufactured by the S. Morgan Smith Company. There will ultimately be seven pairs of 2,500 horse-power each, in addition to two single exciter turbines of 250 horse-power each. The turbines are encased within a steel casing placed within the penstocks, with the steel draft tubes extending twenty feet below the power-house floor, into the tail-race. The shafts extend into the generator compartment, these being direct-coupled to 1,500-kilowatt, revolving-field, alternating-current generators. A similar arrangement is employed with the exciter units, each of which is 150 kilowatts capacity and capable of carrying indefinitely the entire excitation load.

The generators furnish current at 2,200 volts and 60 cycles direct to the station switchboard which is of the Westinghouse No. 11 type, embodying the

most recent and approved forms of current metering and controlling appliances. A considerable amount of power will be furnished to local concerns directly from the station bus, thus avoiding transformation losses, but provision has been made for a complete equipment of 1,500-kilowatt, water-cooled transformers which will raise the pressure to 22,000 volts for transmission should this be decided upon.

The present installation will consist of 1,500-kilowatt units with the exciters and the necessary controlling apparatus, but the entire power-house and equipment have been designed with a view to immediate extensions when warranted by the demand for power. The enterprise is one worthy of the warmest support and should prove strongly attractive to manufacturing interests in search of a suitable location where cheap and reliable power is available.

Book Reviews.

"Handy Electrical Dictionary." W. L. Weber. Chicago. Frederick J. Drake & Company. Leather. 224 pages. 2¾ by 6 inches. Furnished by the ELECTRICAL REVIEW at fifty cents.

This little book will be welcomed by all who are interested in electrical matters. It contains not only a full list of electrical terms, accurately defined and explained, but includes also many definitions of terms used in other branches of engineering. The list of standard wiring diagrams in the back of the book will be found useful by many.

"Electroplating and Electrorefining of Metals." Arnold Philip. New York. D. Van Nostrand Company. Cloth. 680 pages. 5½ by 8 inches. Numerous illustrations. Supplied by the ELECTRICAL REVIEW at $4.50.

This book is the outcome of a revision of Alexander Watt's "Electro-Deposition." The first part includes all the matter contained in Watt's work, although condensed at some points. This is too well known to need comment at this time. To this have been added descriptions of the latest types of apparatus and accessories used in work of this character. A number of later methods of electro-deposition for specific purposes are also described. The second part of the book is entirely new, and considers electrometallurgical processes. The greater part of this is devoted to the consideration of electrolytic copper refining. A brief sketch of the development of this is given, and the details of recent methods are considered at some length. Chapter 2 of this part discusses the cost of electrolytic copper refining, and is an attempt to systematize this work. The subject is treated entirely from the financial side. The various items in the expense of operating are taken up separately and deduced in terms of the yearly output in tons and current density. It is thought that this method can be applied profitably to all metallurgical processes. The other processes taken up in this part are electrolytic gold and silver refining, recovery of tin, electrolytic refining of lead, production of aluminum, and electrolytic refining of nickel. This part includes also a chapter upon electrogalvanizing, which contains much valuable information. The author makes no attempt to discuss the theories of electrolysis, claiming that a technical book should assume these and should concern itself solely with the application of methods. The work forms one of the most complete reference books upon electrolytic processes published.

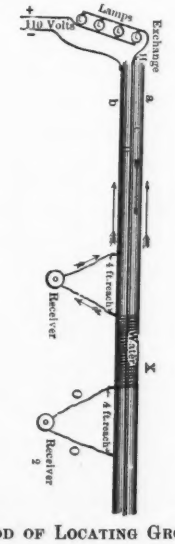
It is to be regretted that the author did not extend the second part of his work to include all the electrolytic processes which are now in use. While it is true that many of these are still in an unsatisfactory state of development, it is difficult for the student to obtain satisfactory descriptions of them as they are applied to-day.

CORRESPONDENCE.

Locating Grounds.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have been using a very simple method of locating grounds on wires in telephone cables. The method may not be new to some, yet as I have not known of its use before I will describe it for the benefit of



METHOD OF LOCATING GROUNDS.

those who have not as yet found a simple and reliable method of locating grounds in their aerial cables. This test will not hold good if the cable in trouble be not free from dead grounds against other cables, guy wires, etc. In the accompanying diagram let *a*, *b*, C, D be any aerial cable or the aerial section of a cable, *a* and *b* of which represent the lead sheath, and C and D of which represent whatever wires are in trouble at the point marked X, which wires should be opened at the other end of the cable. At the exchange end I attach one leg of a 110-volt light circuit to the lead sheath of the cable and the other leg through the resistance of four paralleled sixteen-candle-power lamps to whatever wires are in trouble at X. This connection allows the current to pass through the wires C and D to the point X, where they come in contact with the lead cover which gives the return circuit back to the exchange end. Now if we take an ordinary head telephone receiver, wound to a resistance of one five-hundredth of an ohm, and touch the ends of its leads on the lead sheath of the cable any place between the exchange and the point X a noticeable click will be heard in the receiver, due to a part of the returning current passing through it, while if the same connection be made beyond the point X nothing whatever will be heard in the receiver. In this way the most inexperienced lineman can locate cable trouble within a few inches.

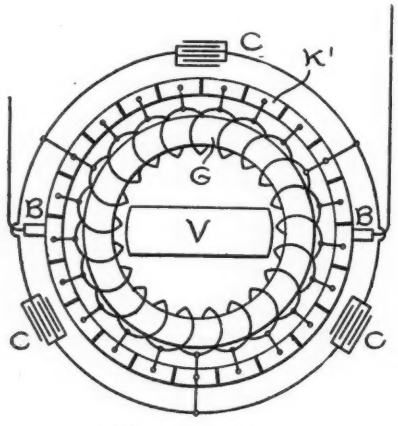
A. B. DUNGAN, Wire Chief,
Consolidated Telephone Company.
Wilkesbarre, Pa., November 10.

Distribution of Electrical Energy in Paris.

A complete record of the electrical distribution in Paris has been kept by L'Industrie Electrique for the past ten years. The present condition is given in a recent article in a number of complete tables, which give for each company the number of central and substations, number and makes of boilers and dynamos, method of distribution, and the number of transformers and accumulators. In the discussion of these tables, it is noted that the underground distribution in Paris is, in general, in good condition, but some circuits are poor. Where cables are run in proximity to gas pipes, the insulation is poor and conditions very dangerous. The method of distribution varies with different companies, some using a three-wire continuous current, and others using alternating currents with transformers and rotaries. The price of electrical energy in Paris makes its use prohibitive in many cases. At the end of 1900 there were in Paris nearly 14,000 arc lamps and over 1,000,000 incandescent lamps. The applications of electrical energy for motive power and for heating have been very little developed. The use of electric elevators is not rare, and is increasing. It is stated that these are more economical than either hydraulic or compressed air elevators. Assuming an ascent of six stories with three passengers, the cost of the trip is given as 0.165 franc for the hydraulic, 0.03 franc for compressed air, 0.045 franc with a hydroelectric elevator, and 0.025 franc for a simple electric elevator, when the cost for the energy is reckoned at 0.061 franc per hektowatt-hour.

Electrical Patents

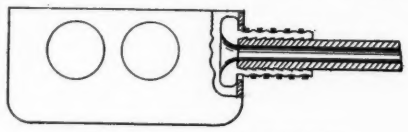
The General Electric Company has obtained a patent on a novel exciting dynamo invented by Mr. Harold W. Buck, of Schenectady, N. Y. The illustration herewith presented is a diagrammatic view of one embodiment of the invention employed in a direct-current, dynamo-electric machine. G is a suitable armature. (Here shown as a Gramme ring.) At equal spaces about the armature connections are tapped off to a corresponding number of sources of leading electromotive force CCC. These may be either condensers, electrolytic cells or overexcited synchronous motors. A commutator K′ is connected to the armature in the usual way, with brushes BB bearing thereon. An unwound field-magnet V is in inductive relation to the armature, and is here shown as internally



Exciting Dynamo.

arranged with respect to the same. The reaction of the leading currents flowing in the condensers will magnetize the field, and the field thus established will generate a direct current, which may be taken from the commutator by the brushes BB, as in other direct-current machines. The leading currents will continue to flow in the armature independent of whatever load-current may be taken from the commutator. In a machine of the character described the field strength depends upon the current flowing into the condensers, so that the field strength and consequently the voltage of the machine may be varied by varying the condenser capacity in any suitable manner. The mechanical construction of a machine, such as described, may undergo many modifications, and its principles may be embodied in many different types of machines without departing from the spirit of this invention. Thus the field-magnets may be either internal and without windings thereon, or they may be external, with short projections forming the pole-pieces. In the latter case the poles are short and the magnetic circuits compact, because no necessity exists for providing space for winding field-coils.

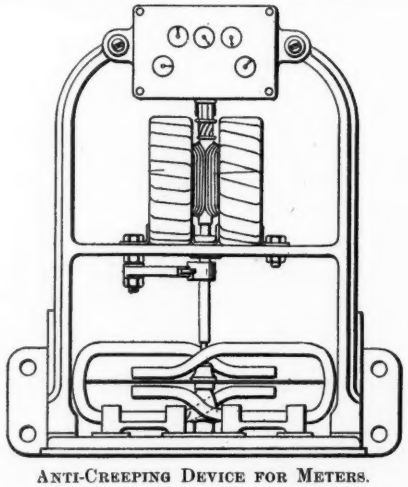
Mr. Frederick W. Erickson, of Boston, Mass., has invented and patented a novel



Outlet Bushing for Conduits.

outlet bushing for conduits. The invention consists of a specially designed outlet bushing made in two parts, having an enlarged inner head with a flaring orifice and a rearward-extending portion, which is adapted when placed together to grasp and firmly hold the end of the flexible conduit. The two parts are held to one another by a screw-nut, preferably in the form of a spring-clip, and securely lock the same to the walls of the outlet box.

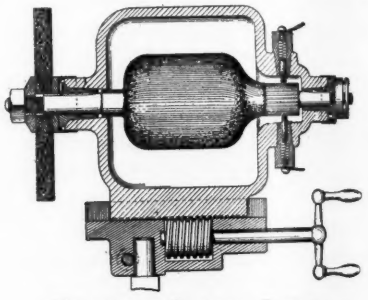
Mr. Caryl D. Haskins, of Schenectady, N. Y., has patented an anti-creeping device for electric meters, which he has assigned to the General Electric Company. As is well known, there is a great liability of electric meters creeping because of the vibration or other causes to which they may be subjected. This is overcome by the present invention in an extremely simple manner. A cam is mounted upon the meter shaft, this cam cooperating with a spring-mounted roller carried by some stationary part of the meter. When, due to rotation of the meter, the roller rides up one side of the cam it produces a retarding effect upon the rotating mem-



Anti-Creeping Device for Meters.

ber of the meter, while as it rolls down the succeeding portion of the cam surface, it causes an accelerating effect practically equal but opposite in character to the previous retarding effect. The number of revolutions of the meter is therefore not perceptibly affected by the presence of the cam and its cooperating roller, which together constitute an anti-creeping device. The parts are adjusted, however, so that the retarding effect is sufficient to overcome any tendency to creeping of the meter which may exist. The roller is preferably journaled upon the free end of a spring arm that is adjustable so as to exert more or less pressure against the cam. Ordinarily, however, the roller is so arranged that its friction is just sufficient to stop any tendency toward creeping of the armature shaft. When the load comes on the meter the cam surface acting on this anti-friction roller deflects the spring, thereby storing up potential energy. As soon as the roller passes over the portion of the cam having the greatest radius, the spring reacts and accelerates the movement of the armature shaft, thereby restoring the energy previously stored and equalizing the retarding effect first given.

Mr. Charles S. Hisey, of Dayton, Ky., has patented a novel electric grinding



Electrical Grinding Device.

device, the rights of which are controlled by the Hisey-Wolf Machine Company, of Cincinnati, Ohio. The leading feature is the adaptability of the device for use in connection with machine tools, to which it serves as a grinding attachment, the tool-holding parts of the latter serving to support the implement, while the work-supporting parts of the particular machine tool serve to hold the work to be ground. The grinding attachment, while being so held by the tool-holding device of the machine tool—that is, by the device holding the cutting tool thereof—is thus equally capable of all the adjustments of such cutting tool and may also be detached or placed in position with equal facility as such cutting tool or moved from one machine for attachment to another. The grinding attachment consists, substantially, of an electric motor, on the armature shaft of which is mounted the grinding-wheel, which

may be the usual emery-wheel. The same is detachably held in place by a washer and superposed nut, and may be exchanged, the same as in the ordinary emery-grinder, with others of different size as to diameter or face, as required. The electrical part of the attachment may be of any approved style and forms a part of the invention to the extent that it may require modification to adapt it to its combination with the grinding device. The parts are supported in a frame, preferably in shape of a closed housing, at opposite ends of which bearings are provided for the armature shaft. Current to rotate the armature, its shaft and the grinding-wheel thereon is supplied to the former through commutator by brushes, held in contact with the former by spring pressure, and carried in insulating plugs, which are seated in bosses, projecting from a lateral extension of the housing. Suitable wires carry the current, connection being made by contact binding screws. The branches necessary for the field are also taken from these wires inside of the housing, and outside all wires are bunched and twisted into one cable of suitable length, which carries at its free end a contact plug, constructed the same as the plug of an incandescent lamp. This plug is of standard size to fit the socket of the usual incandescent lamp, the intention being to make connection in this way—that is, by inserting the plug into an incandescent lamp socket. The attachment is held in position by the tool-holding devices of the particular machine tool on which it is intended to be used at the time—as, for instance, by the tool-post of a lathe or head of a planer. For such purpose it is provided with a shank having flat parallel sides and of dimensions equal to the usual lathe or planer tool, so that it fits like these and may be readily connected and clamped in place or detached. It is clear that after being so attached the grinder is susceptible of the various adjustments which the particular tool would be and the place of which is taken now by its shank.

Mr. George Thomson, of Elizabeth, N. J., has devised an improvement in the art of blasting and describes the invention as follows: "Explosives have generally been used in blasting heretofore, being ignited either by a primer or detonator exploded by an electric current or by a slow-burning fuse. My invention aims to dispense with the use of explosives that produce gases after explosion which are injurious to the health of the miner, or which, owing to their noxious nature, require that he shall wait until they clear away before proceeding with his work after the explosion. According to my invention I utilize electrically generated heat as the means for effecting the blasting operation. In carrying out my invention I place within a drilled hole in the rock or other material to be blasted an electric furnace of suitable construction, and through this furnace, by means of suitable conductors, I pass an electric current of considerable volume, whereby a most intense heat is generated within the furnace and communicated to the immediately surrounding portion of the mass of rock. The amount of heat thus electrically generated may be substantially the same as in electric furnaces

Electrical Blasting Apparatus.

used for smelting purposes, as, for example, those used for the production of aluminum-bronze, carborundum or calcium carbide—or, in other words, the temperature obtained is what is commonly known as a 'smelting' temperature. The electric furnace is especially designed and adapted for insertion into a drilled hole and is so constructed as to facilitate the rapid escape of heat into the surrounding rock. By this means the surrounding wall or core of rock is rapidly raised to a high temperature, approximately to a white heat. The rock is thus heated at a rate more rapid than that at which the heat introduced into it can escape by conduction outwardly into the surrounding mass of rock. Consequently, the inner and most highly heated core or portion of the rock is expanded much more rapidly than the outer mass thereof can expand, and being imprisoned within the outer mass its expansion exerts a strong tendency to disrupt or burst the entire mass of rock. Under some circumstances, the means thus described are alone sufficient to disrupt the rock. This is especially the case with comparatively brittle rock of low heat conductivity and with an efficient form of electric furnace worked to a high heating capacity. Under these circumstances my invention provides a very simple and readily applied means for blasting, since all that is necessary is a suitable dynamo or transformer, and a small cylindrical electric furnace of shape to be inserted into the drilled hole with connecting wires of proper capacity; the miner having only to insert the furnace into the hole, and by means of a switch to turn on the electric current, an operation which is followed in a short time by the cracking open of the rock without any violent explosive action and without the formation of any deleterious gases. For those instances in which the mere heating of the rock, as thus described, is insufficient to effect the blasting, my invention provides a further step. According to this part of my invention I first apply heat within the drilled hole in the rock, in the manner already described, until the rock surrounding the hole is heated to a high degree, and then I cause the introduction into contact with the heated mass of a suitable quantity of water or other suitable liquid, which is vaporized with great suddenness, whereby is generated within the drilled hole a pressure sufficient to disrupt the mass of rock. I prefer water to other liquids, because in its gaseous form it is innocuous, its steam quickly condensing after the explosion, so that the miners can immediately return to work without inconvenience or danger. In carrying out this part of my invention it is necessary to close the drilled hole by some suitable tamping—such, for example, as is commonly used in blasting with an explosive charge. In order to prevent the blowing out of this tamping by any gradually accumulating pressure preceding the liberation of the liquid and the consequent generation of an explosive pressure, I provide through the tamping a minute vent-passage or needle-hole, so that any gradually generated gas may freely escape. For introducing the liquid at the proper time into contact with the heated mass I may place a suitable quantity of the liquid in a sealed vessel or can in any suitable location within the drilled hole, so that it shall be somewhat protected from the most intense heat in order that the rock may be highly heated before sufficient heat is communicated to this vessel to liberate the liquid. The liquid may be liberated either by the melting of some portion of the wall of the vessel—as, for example, its soldered joints, by the accumulating heat—or by the bursting of the vessel by the expansive force of the liquid due to the heat which is transmitted to it. In either case the liquid is liberated in sufficient mass, so that, flowing into the drilled hole or bore around the electric furnace, it comes in contact with the nearly white-hot rock and is vaporized with great suddenness so as to generate a large volume of steam or other gas, as the case may be."

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Oil Motor Cars.

In the discussion of Captain C. C. Longridge's paper on oil motor cars a number of interesting points were brought out. The author held that the water-jacket was doomed by the growing use of steel cylinders, but the use of high-power jacketless cylinders would necessitate a reduction in temperature. For this purpose adding water to the oil would be effective. The fuel in this case should not be introduced into the cylinder except at the point of ignition. Lubrication at high temperatures was another point that needed study. Professor T. Turner discussed the composition of materials used in cylinder construction. Steel was the best, but this should be in the form of solid-drawn tubes, these being stronger, weight for weight, as well as more trustworthy. If the desired properties could be secured with a low carbon steel it would be better not to use high percentages. The qualities needed more strength, toughness and good wearing properties, and carbon was necessary for good wearing. A steel with 0.15 per cent of carbon would meet all requirements. Mr. G. Iden said that the horizontal engine enabled a more graceful body to be built, but that the vertical had more advantages. The engine described in the paper seemed too complicated for general use. These machines are seldom operated by a mechanical engineer, and for this reason all parts of the machinery should be as simple as possible. The strain on the exhaust valves was very severe, and the best results were obtained when these were made of pure nickel. These lasted ten times as long as steel. The speaker had found that cast iron for the cylinders was satisfactory if careful attention was given to the design so as to secure perfect castings. Lubrication of the cylinder is easier when this metal is used.—*Engineering* (London), October 24.

Researches with an Alternating-Current Arc at High Potentials.

The advantages claimed for the use of high potentials in arc light studies, as given by Herr B. Monasch, are many. When low potentials are used, the arc must be started either by bringing the carbons together, and then drawing them apart, or by passing a spark from a Leyden jar between the electrodes, or, finally, by the method described by M. G. Maneuvrier. In this method the arc is surrounded by a globe and the air exhausted, and then suddenly allowed to rush in. This kindles the arc. In the first of these methods, one disadvantage is that the carbons can not before the experiment be set at a fixed distance apart. The other methods of starting call for undesirable accessory apparatus and complicate the work. A further disadvantage of the low-potential arc arises from the relatively large currents required. These heat the apparatus and make it difficult to secure constant conditions. If the carbon is coated with metal, heavy currents coat this thickly with an oxide, while if metallic electrodes are used these are quickly melted away. In the author's work the intensity of the current varied from 0.02 to 0.07 of an ampere, and this intensity merely caused a slight skin to form over the surface of the electrodes, which did not appreciably increase their thickness. The metallic electrodes were very little affected by these small currents, and the arc burned under constant conditions for some time. The high potential was secured by a step-up transformer. The current was measured by a hot-wire ammeter, and the potential by an electrostatic voltmeter. A dynamometer wattmeter could not be used in this work because of the relatively large current required to operate this instrument. For this reason a static wattmeter was used. The arc was surrounded by a glass globe to prevent currents of air from affecting it, and this globe was filled with air dried by passing it through sulphuric acid. By this arrangement constant conditions were secured after three minutes' burning, and very reliable readings were obtained. In Ayrton's work, where carbons were burned in dried air with continuous currents of low potentials, often it took half an hour to obtain constant conditions. The results of these researches show that the energy varies directly with the distance between electrodes if the current is constant. The power-factor also varies directly with the length of the arc. A study of the effect of air pressure on the fall of potential between electrodes shows that the voltage constantly falls with the decrease in pressure. Previous researches have been thought to show that there was a critical point at about one atmosphere, below which the voltage would increase with the decrease in air pressure. This critical point was not found, although the pressures were carried down to 100 millimetres of mercury. The consumption of energy and the power-factor also steadily decreases with the decrease in pressure. Further results are promised in the near future.—*Electrotechnische Zeitschrift* (Berlin), October 30.

Recent Experiments on Optical Telephones.

This article gives an interesting description of Herr E. Ruhmer's latest experiments in wireless telegraphy. It has been but four years since the first tests were made with the speaking arc, and recent results indicate that optical telegraphy may eventually become of considerable importance. Herr Ruhmer has been able to telegraph seven kilometres by day as well as by night. In daylight the receiver must be shaded from direct action of the sun's rays. This system is thought to be of great value for military and naval use, as the signals can not be intercepted by the enemy as is the case with wireless telegraphy. The operation of this system depends upon the effect produced by a varying current upon the temperature of an electric arc. The variations in temperature produce corresponding variations in luminous intensity. If these variations in current are produced by a telephone transmitter the corresponding variations in the light emitted are sufficient to transmit messages if a suitable receiver be supplied. The receiver consists of a selenium cell used in connection with a battery and telephone receiver. Selenium has the property of varying in resistance with the illumination falling upon it. The transmitting apparatus employed in these tests consisted of a hand-fed arc lamp supplied with current from a battery. The current varying in intensity from four amperes for a distance of one to two kilometres up to sixteen for a distance of seven kilometres, a parabolic reflector, thirty-five centimetres in diameter, threw

the light in the proper direction. The receiver was a similar reflector, in the optical axis of which was placed a cylindrical selenium cell. The chief difficulty met heretofore has been in securing a sufficiently sensitive selenium cell, those used formerly responding but little to the short wave-lengths emitted by the arc. The author has overcome this difficulty and can construct selenium cells to respond to any desired wave-length. The cell must also respond quickly, that is to say, its resistance must change instantly with the change in illumination. These cells are enclosed in a vacuum, the tube being of thin glass.—*Electrotechnische Zeitschrift* (Berlin), September 25.

Electrometallurgical Problems.

This is the third paper by Mr. A. A. Beadle, and in it the author takes up the question of the electrometallurgical production of zinc. Zinc occurs in nature chiefly as the sulphide or blende, and is generally associated with iron, arsenic, etc. In the present method of reduction great difficulties are encountered. The ore is first reduced to the oxide and then mixed with carbonaceous matter and distilled, the condensed zinc being cast into ingots. In this form it contains iron and other impurities. The amount of fuel used is excessive, a good deal of zinc is lost during the operation, and the retorts deteriorate rapidly, while a large amount of handling is required. Many methods of treating the ore electrolytically have been tried, but few can be said to be satisfactory. It is not difficult to obtain the zinc in solution, but there is great difficulty in depositing it electrolytically in a solid metallic condition. Fair deposits of zinc, however, may be obtained from the sulphide or the double sulphides of zinc and the alkaline metals or from zincates of potash and soda, but the process requires a good deal of care and skill in handling. Zinc can be reduced from a fused hydrous chlorate, and this seems the most promising direction for development. The most abundant deposits of zinc are those in which the zinc blende is associated with galena or lead sulphide. Here each metal interferes with the reduction of the other. Most of these deposits contain silver. Mechanical separation is not satisfactory, because of the intimate mixture of the two compounds. All attempts at treatment of this ore may be classed under two headings—first, obtaining the metal in a solution, which is subsequently electrolyzed, and obtaining the metal in the form of fused salts, either directly or indirectly, and subsequently electrolyzing the fused salts. Most of the methods first classed have been based on the fact that in partial roasting the sulphates are produced, which enables the sulphate of zinc to be washed out, leaving that of lead behind. In the Ashcroft process, ferric chloride was used. Almost every solvent has been patented in this connection, including the mineral acids. The same difficulties are met with here as in the treatment of the more simple ores. The rapid accumulation of impurities in the electrolyte, and the deterioration of the electrodes, present almost insuperable obstacles. For the second class of processes, the halogen salts appear to be best suited. In some of these the ore is first roasted to get the sulphate, which is then leached out and converted into the chloride. Another method consists in mixing the ore with zinc chloride, and then raising it to just below red heat. In one method the chlorine is passed over the red hot ore. In one of the latest processes, which has been developed by Ashcroft and Swinburne, the ground ore is passed into a bath of molten zinc chloride, which acts on the silver and lead sulphides. Chlorine is then passed through and acts upon the zinc sulphide, converting it into chloride. The chlorides of lead, silver and other metals are thus produced, and the metals can be fractionally electrolyzed out. The economical results of these various methods remain to be seen, but they seem to indicate the direction in which successful development is likely to be made.—*Electrical Review* (London), October 24.

Work of the Reichsanstalt in the Year 1901.

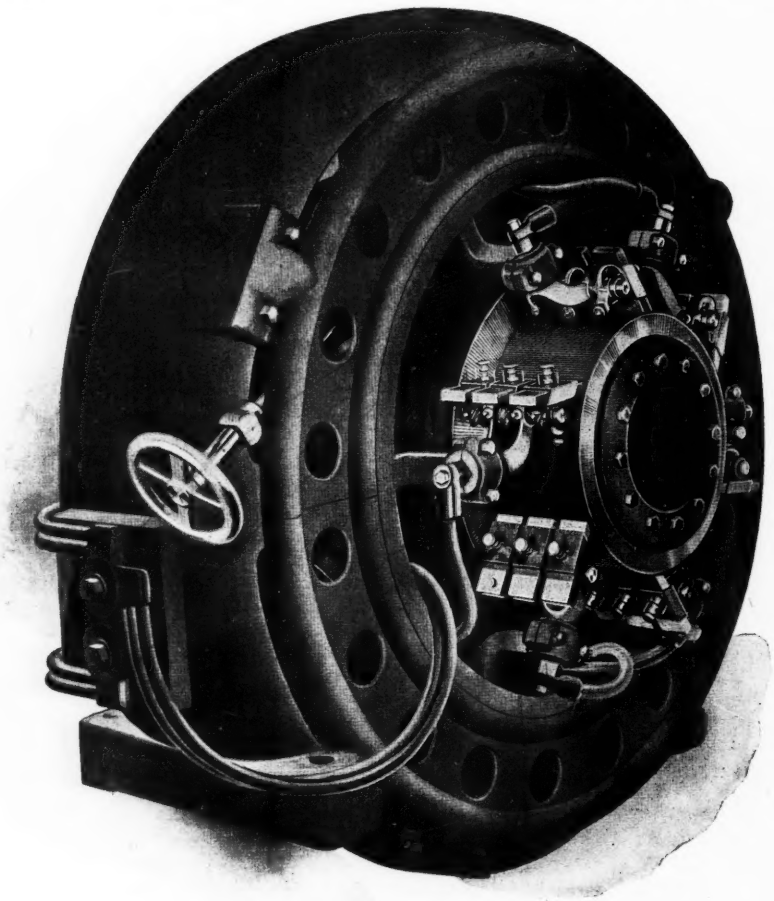
The official report of the work of the Physikalische Technische Reichsanstalt for 1901 has been presented, and this article gives a fair abstract of the same. The following are items relating to electrical matters. On January, 1902, the German law concerning electrical units became valid. The standard resistance coils, consisting mostly of manganin, have been retested and found very constant. This applies also to the small resistances varying from 0.1 to 0.0001 of an ohm, which were first tested in 1895. The Deprez-d'Arsonval galvanometer, constructed for this work by Siemens & Halske, has proved very satisfactory. Technical tests in behalf of the trade were made on various samples of conductors and resistance material. Of the thirty-one resistances, wire or sheet, which had been tested by the Reichsanstalt, twenty-one upon retesting had, during the three years or more of their use, remained constant within 0.02 per cent. One resistance of 0.001 ohm had gained 0.12 per cent in four years, while another of the same resistance lost 0.23 per cent in two and one-half years. Only two of these resistances did not maintain the desired constancy of 0.1 per cent, but these had been badly used. Large numbers of meters of various types have been tested and distributed to the various works, where they are used under different conditions. These are kept under control and the boxes sealed, and the operation of these meters will be watched closely. For testing meters a double three-phase generator was constructed by Siemens & Halske for the electrical laboratory. The shaft bears two revolving magnet systems, one having an output of five kilowatts, being permanently keyed to the shaft. The other, of one and one-half kilowatts, can be shifted by means of a worm through an angle of 100 degrees. In this way any phase difference between the currents in the current and pressure circuits of the meter can be obtained. The study of normal cells has been continued. After disposing of the objection raised by Cohen against the standard of cadmium amalgum, the solubility of mercuro-sulphate in water and cadmium sulphate was taken up. It was found that a concentrated cadmium sulphate solution dissolves three times as much mercuro-sulphate as does water. Investigations on the heat of the solution and the solubility of zinc sulphate are being conducted. Of 125 Clark cells tested professionally, twenty-eight were rejected as exceeding the error of 0.001 volt, or for other reasons. The normal electromotive force of the Clark cell is now assumed to be 1.4328 volts at fifteen degrees centigrade, and that of the Weston cadmium cell to be 1.0186 at twenty degrees centigrade. The magnetic investigations chiefly concern the comparison of methods. Tests with the new wrought-iron yoke again proved that the resulting inductions depend upon the rate of change in the magnetizing currents. When the latter are increased by great steps they are higher than those observed when smaller steps are applied. Work on hysteresis and Foucault current losses has been conducted in connection with various firms. Eight specimens of sheet metal have been tested by Epstein's method. The Foucault losses decrease in long-continued tests, owing to heating, and the total loss and the proportion of the two components are altered with the conditions of the test. It makes a difference whether the test is begun with low frequencies and carried on to high, or the reverse. Hence it has been resolved that in practice only the total loss with a density of 10,000 lines at fifty periods should be stated in watts per kilogramme at a temperature of thirty degrees centigrade, and that the separation of the components should not be required.—*Engineering* (London), October 31.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Engine-Type Motors and Generators.

Several unique features have been incorporated in the design of the engine-type motors and generators of the New England Motor Company, Lowell, Mass. The armature is of the bandless type, and it is claimed that no sacrifice has been made in the shape of the teeth in order to produce this result. This company has, at the expense of a great deal of labor and experimenting, produced an armature in which the straight shape of the tooth, with its resultant advantages, is retained, and at the same time the wedges which retain the coils in place are held as firmly as though there was an overlapping or dovetailed edge. At each end of the armature core, and at intervals throughout its length, a device known as an interlocking and ventilating ring has been placed. This consists of an annular casting of soft composition, such as copper with a very small percentage of tin. This casting has teeth projecting from it to coincide with the teeth of the armature core. These teeth, while being, so far as the sides are concerned, of exactly the same shape as those of the core, have the tops hollowed out so as to leave two projecting horns, one on each side of the tooth. After the coils have been placed in the slots of the core, hardwood wedges are driven in over them, and then by means of the peen of a hammer these horns are bent outward over the wedges, locking them into place. This method does not reduce the amount of iron in the core, as it simply consists in so manufacturing the end-plates and ventilating discs as to allow them to be used for interlocking rings to hold the wedges in place. Should it become necessary to remove the coils, the ductile nature of the composition used allows the horns to be straightened again and a new coil inserted, when the horns may be bent down again, locking the coil in place.



ENGINE-TYPE MOTOR AND GENERATOR.

Another characteristic feature of this apparatus is the method of support of the brush rigging. It will be noticed in the accompanying illustration that this brush rigging is of the ring type, and is supported from the field yoke of the machine. Two rings are employed. One is a heavy, split outside ring, which is rigidly bolted to the field yoke of the generator, and is bored out to a true spherical shape, so grooved as to support the smaller ring which, in turn, supports the brushes. By this means a true circle is formed for the smaller ring to rest in, and a further advantage is secured in the fact that the ring is light and easily moved.

The armatures of these machines have the usual form-wound coils, but a peculiarity of manufacture consists in the fact that the slots are separately insulated with micanite troughs before the coils, which have been carefully taped, are placed therein. The commutators are large and give ample surface. The brushes are of carbon, and the brush-holders are of an improved type.

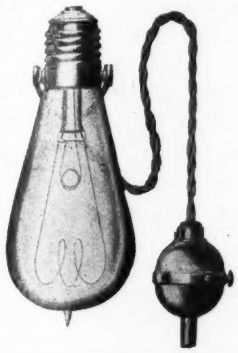
The smoke nuisance is receiving much attention at the hands of the city authorities of Providence, R. I., who are endeavoring to obtain necessary legislation for its abatement. It is a matter of interest that the three largest industrial concerns in the city have voluntarily encouraged this movement by offering to install apparatus in their power stations which would entirely prevent the formation of black smoke. With this purpose in view the Rhode Island & Suburban Railway has contracted for a large equipment of Roney mechanical stokers for its new boiler plant. The plant will have an ultimate boiler capacity of 8,300 horse-power. The above stokers will be used throughout.

Another large concern, the Narragansett Electric Lighting Company, is also installing a complete equipment of Roney stokers, comprising twelve stokers of the quadruplex type operating under Babcock & Wilcox boilers of 4,500 horse-power capacity.

A third industrial plant employing these stokers is the Brown & Sharpe Manufacturing Company, where Roney stokers, under two batteries of Babcock & Wilcox boilers, have been in use for some time with excellent results. The success of this installation undoubtedly furnished the incentive toward the smoke-prevention movement.

A New Turn-Down Wrinkle.

The popularity of an incandescent lamp which can be regulated so that the intensity of illumination may be varied from a dim light to that of the ordinary brilliancy is unquestioned. There are a great many cases, however, where the lamp

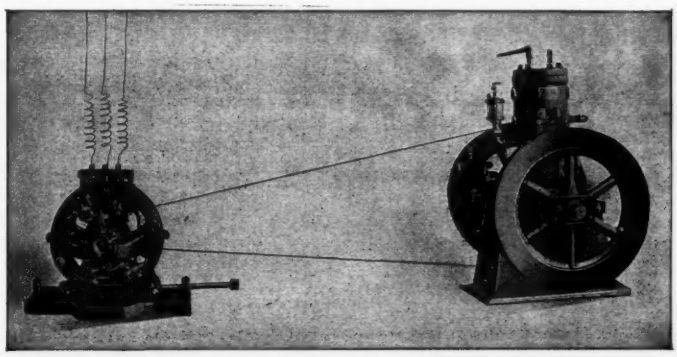


Long-Distance Turn-Down Lamp.

is placed in an awkward position for manipulating the bulb when the mechanism for reducing the light requires this method of procedure. A recent attachment to a popular form of turn-down lamp is in the form of a pendent push-button, hanging down from the electric bulb by a conducting cord. This cord can be attached to a special turn-down lamp by means of snaps like a glove fastener, the cord being of any length desired. This may be extended to any position, so that the light may be turned down from any position whatever. The accompanying illustration shows the appearance of the turn-down lamp and the pendent push-button, which is a specialty manufactured by the Phelps Company, Detroit, Mich., maker of the famous "Hylo turn-down lamp.

Stationary Motors.

The motors manufactured by the Lowell Model Company, of Lowell, Mass., a type of which is shown in the accompanying illustration, are of the two-cycle compression type, and obtain an impulse at each revolution of the crank. The ports are opened and closed by the piston, which obviates the use of poppet valves. Gasoline is fed from the tank to the vaporizer, where it is mixed with a proper amount of air and is drawn into the crank case by the action of the piston on the upward stroke, then compressed by the downward stroke, and, as the piston uncovers the transfer port, the compressed charge is forced into the cylinder, and again compressed by the upward stroke, when it is ignited by the electric spark, the piston being nearly at the top of the stroke. The expansion of the ignited charge forces the piston downward, and the burned gases are expelled from the exhaust port, which is uncovered by the piston in advance of the inlet port. Several improvements have recently been added to this model, the crank case being joined horizontally with the centre of the shaft. All of the shaft bearings are provided with stuffing nuts, which prevent a loss of compression in the crank case, even when the bearings are considerably worn. The cylinder heads, as well as the cylinders, are thoroughly water-jacketed, and circulation is effected by a pump connected to the engine shaft. The speed is variable, but is controlled by a throttle in the transfer port. An improved electric igniter is used, which ensures a large spark when starting or at speed. These engines are run in either direction, and the amount

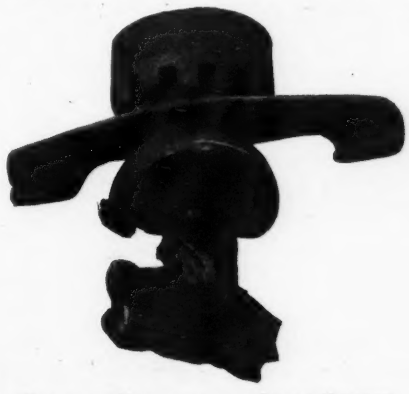


Stationary Motor Belted to Generator.

of gasoline consumed is claimed to be remarkably small. With motors of a stationary type, a heavy stationary base is used for the mount, and two heavy balance-wheels are added, with a belt pulley and governor.

An Interesting Specimen.

The illustration herewith shows a straight-line hanger and ear which was



Trolley Hanger after Short-Circuit.

taken from the line of the Mill Creek Valley Street Railway Company, St. Bernard, Ohio. The damaged appearance of the hanger and ear was caused by a dead short-circuit between the trolley and ground. It is stated that in some way the positive trolley came into contact with the negative or ground trolley on one of the cars, causing a short-circuit on the line. The circuit-breakers were set at 2,000 amperes, and did not open until the engineer opened the circuit by pulling out the breaker; but at the time this was done it was noticed that the short-circuit was carrying 1,500 amperes. The illustration shows the disastrous nature of the arc caused by the short-circuit, which melted away the ends of the trolley ear and the lower part of the skirt of the hanger supporting it. The hanger was a type "D," made by the Ohio Brass Company, of Mansfield, Ohio, and the insulation was of the well-known "Dirigo" brand made by the same company. It is remarkable that despite the fact that the hanger and ear was so damaged by the arcing that the stud bolt of the hanger was partially melted away and fused on to the boss of the ear, the insulation was practically uninjured, with the exception of a slight charring at the lower edge of the insulated bolt. A test of 500 volts afterward applied between the hanger casting and ear showed that the insulation of the hanger was still perfect.

Electrical Car Heaters.

A resistance coil which will pass a certain amount of current may be made of a short length with a high resistance or a long length of wire with a low resistance. If the resistance of the coils is equal the same amount of current will flow through each, and each coil will give off the same amount of heat. The conversion of electrical energy to heat takes place in accordance with well-known laws and in known proportions, the equivalents of which are standard and can not be produced without a proportionate amount of energy. Consequently a short coil of high resistance wire having a small surface

must necessarily operate at excessively high temperature in order to dissipate the same amount of heat as the longer coil of low resistance wire having a much larger surface. It is in this principle that the success of the electric heaters, manufactured by the Consolidated Car Heating Company, Albany, N. Y., is

FIG. 1.—COMPLETE COIL, WITH RESISTANCE WIRES AND LEAD WIRE.

claimed to lie—that is, a large heating surface operated at a moderate temperature.

The resistance coils employed in this system are made of special galvanized iron wire. By reason of the large radiating surface, which is made possible by the McElroy spiral coil construction, the wire is heated only to a moderate degree, avoiding high temperature to which a high resistance wire is necessarily subjected and which invariably crystallizes the wire, especially when accompanied by vibration. In all the electrical heaters manufactured under this system the resistance coils are perfectly supported at every point and the vibration of the coil is claimed to be impossible. The spindle supporting the coil consists of three-eighths-inch square wrought-iron rod on which are strung cylindrical porcelain tubes which are so designed and fitted that a helical groove extends from end to end.

Specially designed eccentric porcelain bushings are on either end of the rod, and pass through the end-plates of the heater case. The wire for the resistance coil is wound in a close spiral spring, and insulated copper lead wires are attached to both ends by twisted and soldered joints. This coil is wound between the ridges on the porcelain spindle, under suitable tension, and the lead wires are passed through the eccentric bushings and firmly fastened without the use of binding-posts.

This construction gives the greatest possible length of wire in the given space and disposes every portion of the large surface presented so that a large quantity of air comes freely in contact with it and passes out into the car in a steady stream at a temperature best suited to the comfort of passengers and the heating effect on the air in the car. In each heater there are two resistance coils placed one above the other. The upper coil is of greater resistance and consumes less current than

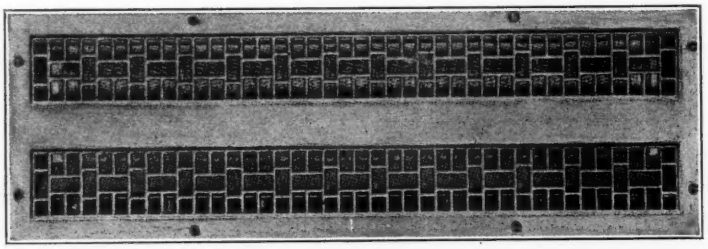


FIG. 2.—PANEL HEATER FOR LONGITUDINAL SEAT CARS.

the lower. The coverings of the lead wires to the two coils are of different colors, and can thus be easily distinguished. The top coils of all the heaters in the car are in series, and the bottom coils of all the heaters in series. Thus,

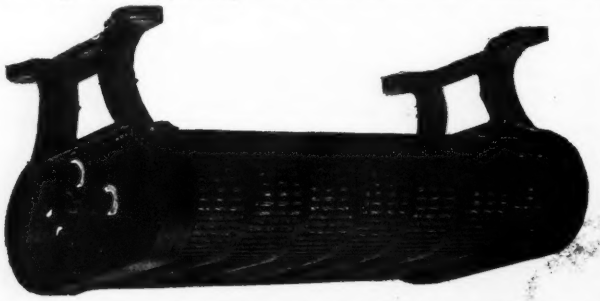


FIG. 3.—STANDARD HEATER WITH THREE INDEPENDENT CIRCUITS.

whenever current is used, heat is given out the full length of the casing of every heater in the car. At the same time this method of wiring is claimed to be the simplest and most economical in time of equipping and material used.

Fig. 1 shows the complete coil with the resistance wire, porcelain bushings, end-plates and lead wires in position.

Fig. 2 is an illustration of a panel heater for longitudinal seat cars, with two resistance coils of the above-described construction extending the entire length of the case. The heater front is of cast iron and is finished in either black japan or gold bronze. The back is of stove-plate and is carefully designed to give maximum strength for a given weight. The heater is lined with heavy asbestos mill board, which is bound with sheet metal and firmly riveted to the case. A perforated back provides for a circulation of air between the case and the asbestos lining so that the heat which would otherwise be wasted under the seats is delivered into the car.

Fig. 3 shows the type of heater which was designed to meet the specifications of the Manhattan Railway Company, New York city. This was adopted as standard and a contract given for equipment of 1,200 cars requiring 21,600 heaters. The standard spiral coil construction is used, but there are three independent circuits through each heater. The coils are all alike, and regulation is secured by the operation of one, two or three circuits as required.

A Jack for Street-Car Service.

This jack is constructed with two steps and is designed for steam, electric and street railway service, being used in track construction and also as a car-jack in cases of emergency, such as derailments and accidents, where cars have to be lifted quickly and lowered gradually. The rack,

JACK FOR STREET RAILWAY SERVICE.

with steps, can be easily detached and used for service as a complete lifting jack adjusting from 14¼ inches to 23 inches with a capacity of 1,200 to 1,400 pounds. The complete weight of the jack is thirty-five pounds.

This jack is manufactured by the Bray Manufacturing Company, Incorporated, Newark, N. J., the New York agency for which is Mr. H. M. Shaw, 115 Broadway, New York city.

Electric Blue-Printing Apparatus.

The importance as well as the general utility of the application of electricity to blue-printing appeals to every architect, engineer and draftsman, to whom the production of blue-prints with the best

Electrical Blue-Printing Apparatus.

of solar facilities has doubtless often been vexatious.

The dark and cloudy days of winter, as well as the rainy days in the summer and at all times during the year when the light is poor, smoky or irregular, makes the advantage of having an electric equipment of great benefit to the possessor. The accompanying illustrations show one of the latest and most advanced types of machines for printing by artificial light.

The apparatus consists of a cylindrical printing frame, composed of two heavy curved plates of glass, bedded in soft material in an adjustable, though rigid, frame, together with two tubular uprights which support the arc lamp and automatic drive mechanism. This drive operates the lamp, having means for lowering it through the cylinder and then automatically raising it again to its former position.

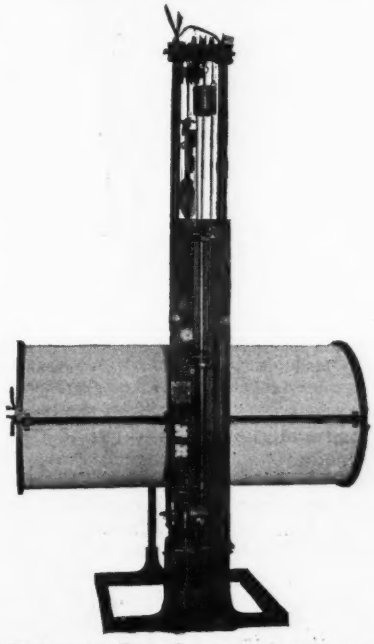
The cylindrical frame revolves on trunnions, so that it can be swung to a horizontal position, which is the most convenient method for inserting or removing tracings and paper from the frame.

In operating, the cylinder is revolved to a horizontal position, and the tracings and sensitized paper are placed around the outside of the cylinder, being confined by stout canvas covers which are drawn tight by turning a lever, thus ensuring perfect contact between tracings, sensitized paper and the glass. The cylinder is then swung to the opposite horizontal position and the same manipulation repeated, after which it is returned and locked in vertical position and is ready for printing.

By simply touching a lever the arc lamp starts in its descent through the centre of the cylinder at a speed which can be regulated to suit the sensitiveness of paper employed. When the lamp has reached the lowest point of printing surface, it automatically reverses its motion and quickly returns to its original position above the cylinder.

The characteristic features claimed for the apparatus are as follows:

The machines are self-contained; no



Electrical Blue-Printing Apparatus.

brackets or pulleys on wall or ceiling are required.

The automatic drive mechanism for raising and lowering the lamp is a novel, ingenious and reliable device. The downward movement of the lamp is even and steady, and can be regulated at will, to take from five seconds to an hour, depending upon the degree of sensitiveness of paper used.

When the lamp has passed the printing surface, thereby completing the exposure, the motion of the lamp reverses automatically, and returns quickly to its original position. No time is lost and no hand labor is required.

The limit of the motion of the lamp can be set according to the size of prints to be made.

The arc lamps furnished with the machine are of a special pattern and the best adapted for the purpose, giving the highest actinic effect and a strong, uniform and steady light.

Gas Power Development.

The gas engine central station is assuming material form in several recent projects for the utilization of gas fuel for power and lighting purposes. A complete equipment of gas generators, gas engines and direct-connected generators is in process of installation in several important American industrial establishments, *viz.*, the Winchester Repeating Arms Company, New Haven, Ct.; the Atlantic Refining Company, Philadelphia, Pa.; the Consolidated Industries Company, Batavia, N. Y., and the Rockland Electric Company, Hillborn, N. Y. The first of these equipments to be put in operation will be that of the Winchester Repeating Arms Company, at New Haven. The power-house has been specially designed for the new gas apparatus and the entire power for manufacturing and lighting purposes will be furnished from this point. The engines are of Westinghouse make of the standard vertical, three-cylinder, single-acting type, aggregating 500 horse-power. They are each direct-connected to 250-volt direct-current generators and are furnished with gas fuel from Loomis-Pettibone gas generators located in the adjoining producer room. Two additional engines of the vertical type are employed as auxiliaries. Suitable gas holders are provided for insurance of continuity and uniformity of fuel supply.

The power station of the Atlantic Refining Company will be equipped with a new type of Westinghouse gas engine and a type new to American practice, *viz.*, the horizontal, double-crank, double-acting engine. There will be two engines, each of 500 horse-power and each engine will be direct-connected to a 350-kilowatt, twenty-five-cycle three-phase generator, arranged for parallel operation. This

feature is of much interest and importance at the present time and presages further development in this branch of industrial enterprise. The engines will operate upon a rich oil gas of approximately 1,200 B. T. U. per cubic foot.

The equipment of the Consolidated Industries Company is of still greater interest by reason of the arrangements for the most efficient utilization of the fuel supply. The plant will supply three products, *viz.*, metallurgical coke, fuel gas and electricity. A special process will be used yielding metallurgical coke, and fuel gas as a by-product. The electricity for lighting and power purposes will be generated at a central power station employing 250-horse-power Westinghouse gas engines of the new horizontal double-acting type, direct-connected to alternating-current generators operating in parallel and supplying current at 1,100 volts to the distributing network. A smaller generating unit will also be used for light loads. The installation is an instructive application of processes having for their object the utilization of waste products.

Another gas power enterprise and one capable of certain ultimate development is the Rockland Electric Company, which, together with the Ramapo Iron Works and the Ramapo Foundry Company, is comprised in the Snow interests. The installation will consist of an independent gas manufacturing plant employing the Loomis-Pettibone process, and a power plant containing direct-connected gas engine generator units. The producer plant will supply water gas to the iron plants mentioned for heating and metallurgical purposes, and electric power to all industrial plants in the vicinity, including the Mahwah branch of the Standard Brake Shoe Company, located about four miles distant from Hillburn. The plant will also supply current for lighting throughout the Ramapo Valley district, of some fourteen miles in extent, comprised between the towns of Ridgewood, N. J., on the south, and Hillburn, N. Y., on the north. The gas engines installed are also of the new horizontal double-acting type of 350 horse-power each, equipment aggregating 1,200 brake horse-power, or 1,400 brake horse-power maximum. The engines are direct-connected to polyphase generators, and constructed to operate in parallel. A 128-horse-power vertical gas engine unit will also be employed for carrying light loads, and assisting at peak loads. A small amount of direct-current power will be furnished for a short time from one of the main units, which will be temporarily a direct-current unit, but it is the intention to ultimately replace this direct-current generator by an alternating-current generator, thus converting the entire plant into a polyphase gas engine central station.

These four installations, and especially that at Hillburn, should prove of considerable interest to gas engineers and manufacturers in general as representative of a decided and welcome advancement in the field of power development. The machinery will in all cases be furnished and erected by Westinghouse, Church, Kerr & Company, engineers, New York.

Feed-Water Heaters and Purifiers.

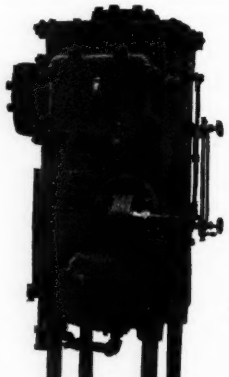
There is very little doubt but that a properly designed exhaust-steam feed-water heater will effect a considerable saving in a steam plant, no matter what the conditions of installation may be. This is equally applicable whether the plant is operated under high pressure, exhausting free to the atmosphere, or whether operated under back pressure, using the waste steam for heating or drying, or whether it is operated condensing.

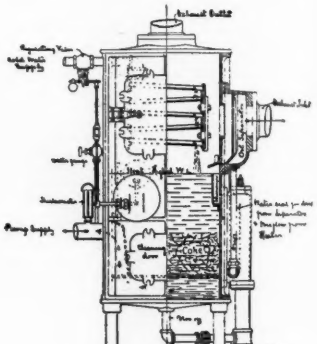
In the heaters shown in the accompanying illustrations—except the smaller ones, which are cast in one piece—each side is formed of one or more strongly ribbed cast-iron plates, bolted together at the flanges, and made steam and water-tight with rust joints calked from the inside. Suitable stay tubes and bolts are used in the larger sizes, so that the shells, being strong and rigid, will not be affected by the pulsations of the exhaust steam. The top and bottom plates are also of cast iron, the latter either being dished or set at a slight angle to admit of complete drainage through the blow-off pipe.

The oil separator, through which the exhaust steam enters the heater, is bolted on the outside of the shell. The separator is self-cleaning and is drained through a drip pipe connected to the water-seal on the waste pipe. The upper portion of the heater contains the trays, which are interchangeable and removable, and which vary in number and arrangements according to the size of the heater. Each is inclined, and the edge over which the water drips is serrated or saw-toothed for breaking up the water.

The trays are held in place by cast-iron guides, securely bolted to the shell of the heater. Each set of trays is suspended in the steam space, with passages between the tray supports and the sides of the heater, giving a great area for the passage of any surplus exhaust. From the opening in the heater, through which the cold water enters, a brass pipe with ell and nipple at one end takes the water to an open distributing box or trough extending across and above the trays. Slots are provided in the bottom of this box, through which the water flows on to the upper trays.

Outside of the heater, on the inlet pipe, is placed a double disc or balance valve for regulating the cold water supply. This valve is controlled by a ventilated copper float carried in the heater. Any change in the level of the water raises or lowers this float, opening or closing by crank and lever connections the regulating valve. A suitable brass stuffing box prevents leakage, the lower portion of the stem of the float being submerged so that any water that might occur in the float through sweating of the copper or from leakage will show on the outside of the heater within plain view of the engineer. Just above the working level the skimmer is placed, extending the width of the heater, which, in addition, furnishes the overflow opening. This trough is drained through an opening in the side of the heater into the water-seal or trap. The seal carries a sufficient head of water to withstand a pressure of about one pound to the square inch.





TWO VIEWS OF THE COCHRANE FEED-WATER HEATER AND PURIFIER.

To provide for carrying additional depositing surface in the form of a filter bed, these heaters are furnished with perforated cast-iron plates of shelving, on which the material used is placed, ensuring the passage of all the water through the filtering bed. Ample provision is made for examining and cleaning the parts of the heater without disturbing any pipe connections, the openings being of large size and conveniently located. The faces or joints of all the cleaning doors and flanged openings are machined and a special form of bolting is used for securing these doors. The tray doors are hinged so that they may be swung to one side. These heaters are manufactured by the Harrison Safety Boiler Works, Philadelphia, Pa.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

REPORT ON CHICAGO UNDERGROUND TROLLEY—Mr. Bion J. Arnold, the expert engineer employed by the council committee on local transportation to report on street railway conditions in Chicago, has finished his report. He holds that the system can be installed and operated successfully in any portion of Chicago. The report is a voluminous document packed with statistics and illustrated with maps. The report contains about 100,000 words. Mr. Arnold is under contract with the city to furnish a complete report for $10,000. He has employed other experts on the work, and has researched the records of all large cities of the United States and Europe for data regarding street railway equipments.

TO CLOSE ELECTRIC LIGHT DEAL—The deal for the sale by the United Railways and Electric Company of $2,000,000 of common stock of the United Electric Light and Power Company it owns has been consummated. It is to be purchased by a syndicate which is to pay $900,000 for the stock and assume expenditures for improvements made since the option, which expired on November 15. In addition to getting control of the light company, the purchaser also secures a contract with the United Railways company to furnish it with power. The electric light company is to be used as a distributing agent in Baltimore for the Susquehanna Electric Power Company. The payment for this stock is not to be made until January 15, and the details of the capitalization of the owning company will not be completed until that time.

A NEW NASHVILLE POWER SCHEME—It is stated that the Great Falls Power Company will at once begin steps to place a $1,000,000 plant at the Caney Fork Falls, sixty-nine miles from Nashville, Tenn., and expects to be able to deliver in Nashville in about a year electricity to the amount of 14,000 horse-power. The company has had engineers making surveys for several weeks, and the theoretic power reported was 19,000 horse-power. The survey is being made with a view of ascertaining the amount and class of machinery that will be required to harness the power of these falls. It is said that the building of the plant will begin at the earliest date possible. The machinery and equipment of the plant will require an expenditure of $1,000,000. The operating expense, as estimated, will be $50,000 annually. The Great Falls Power Company was recently incorporated by Nashville men, and was later granted franchises to sell light and power, the rights of the streets being granted.

ELEVATED COMPANY'S REPORT SHOWS GAIN DUE TO ELECTRICITY—At the annual meeting of the Manhattan Elevated Railway Company, held recently, the present officers and directors were reelected. In his annual report, President George J. Gould said that the year showed an increase of more than 29,000,000 in the number of passengers carried. This is a gain of nearly 80,000 a day. It is attributed in part to the equipment of the road with electricity. The net earnings showed an increase of $1,230,436 over 1901, and the net earnings were $11,067,746. The reports made on the progress of improvements were as follows: "Since the last annual meeting substantial progress has been made with the new equipment. The Second and Third Avenue lines have been completed, with 608 cars in operation. The Sixth and Ninth Avenue lines, on which eighty cars are now running, should be completed not later than April 1, 1903. Among other improvements, the new extension and station in Bronx Park and elevators at 110th street may be mentioned. The new yard and shop facilities are being pushed as fast as material can be secured, and another year should see their completion."

MORE HORSE-POWER FOR BROOKLYN RAPID TRANSIT—With the completion of the new power-house of the Brooklyn Rapid Transit Company now being built at Third avenue and First street, Brooklyn, the efficiency of the entire service will be more than doubled. The new central station will distribute 48,000 additional horse-power over the city where there is now 42,000. The new power will be distributed to six substations, which are now building. The present main station at Kent avenue will be augmented by 6,000 horse-power. It is expected that the increase in power will provide all anticipated requirements for some time to come. The central station will be 200 by 200 feet, built of brick, and have two great smokestacks rising 200 feet. The main station will cost $2,500,000, and will be completed in about a year. The whole expenditure, including the six substations, which are 50 by 100 feet and 40 feet high, will be $4,500,000. A vastly additional feeder system will be required, and subways will be built to carry the feeder cables. The company is now removing wires from certain streets designated by the resolution of the board of estimate, and thousands of feet of feeder cables are now being placed in subways.

TROLLEY EXTENSIONS IN MAINE—It is expected that within the next year 200 miles of electric railways will be built in Maine, making a total mileage for the state of about 500 miles. Governor Hill is said to be the largest holder of electric railway stock in the state, being principal owner in three of the most important lines, and being now engaged in making arrangements for the building of extensions of these lines aggregating 100 miles of track. Rockland and Augusta will be brought within forty-five miles of each other by trolley, just one-half the distance of the present steam road. Thomas J. Lynch, F. G. Kingsman, H. G. Staples and C. R. Whitten, of Augusta, and F. S. Thorne, of Gardner, are to build two lines from Augusta to Waterville, a distance of twenty miles, one on either side of the Kennebec River. A road is to be built in Aroostook County, connecting several important towns; one in Hancock County, from Ellsworth to Castine; an extension of the Bangor and Hampden line to Winterport and Frankfort, and several other short lines. At present there is a continuous system of electric roads from Brunswick to Portland, and thence to Biddeford, Saco and York, and in the near future, by the building of a link between Gardiner and Brunswick, the system will be made continuous from Augusta to York, traversing the most thickly populated section of the state on a route practically parallel with the steam roads.

NOTICE OF MEETING.

PITTSBURG, PA.—The annual meeting of the Railway Signaling Club was held at the Hotel Shenley, Pittsburg, Pa., November 11 and 12. There were about 150 members present and 75 new members were elected. A report was read from the committee on "Compensation and Crank Motion;" report of committee on "When Can an Interlocking Plant Be Economically Operated by Power;" report of committee on "Cost of Installation of Iron and Copper Wire for Line Circuits; also Difference in Cost of Installing and Maintaining Battery on Same." A paper was read by W. H. Elliott, signal engineer, C., M. & St. P. Railway, on "Good Practice in the Use of the Distant Signals." These reports and papers were supplemented by a report of the committee on "Organization" and on "Signaling Circuits," and were discussed at some length. The next meeting of the club will be held in Detroit, Mich. Among the electrical men present were: George F. Porter, of the Atlantic Insulated Wire and Cable Company, and J. E. Ham, of the Hazard Manufacturing Company.

LEGAL NOTE.

TRANSFORMER DECISION—Judge Lacombe handed down this week a decision relating to the Stanley Electric Company's "A O" and "G" transformers, in which the same are declared as non-infringing of Stanley patent No. 469,809. The suit is that of the Westinghouse Electric and Manufacturing Company *versus* the Orange County Gas and Electric Company on a motion for a preliminary injunction. The following is quoted from the decision as being the substance of the same: "The evidence in the case at bar as to the two new types of transformers, 'A O' and 'G,' is much more specific as to the length of wire in a primary coil, and in view of the repeated concurrent testimony of the many experts called by the defendant, it can not be held that the length of wire in primary coil is substantially the same as it would be if such length were determined by the Stanley rule. If it be not the same, we seem to have the very exception suggested in the opinion of the court of appeals, 'some other length covered by the language of the claim, but not of the rule,' and the infringement is not shown. The motion is denied."

PERSONAL MENTION.

HON. JAMES A. MYERS, of the electric manufacturing house of Robbins & Myers Company, of Springfield, Ohio, was a New York visitor last week.

MR. C. J. FIELD has joined the staff of the United Engineering and Contracting Company, of 13 Park Row, New York, and will have charge of the conduit work of this company.

MR. NORMAN MARSHALL, president of the Marshall-Sanders Company, Boston, Mass., has just returned from a ten days' trip through the West. He reports a healthy condition of business.

MR. GEORGE A. McKINLOCK, Chicago, president of the Central Electric Company, is spending a few weeks in New York city with his wife and son, Alexander, the guests of the Manhattan Hotel.

MR. W. M. PROBASCO, of the Westinghouse companies publishing department, was recently badly shaken up in a railroad accident and was invalided for about a week, but is now rapidly recovering and is again able to look after the interests of his important companies, with headquarters in New York and Pittsburg.

MR. EDWARD R. TAYLOR, who has made so much progress in the electric production of bisulphide of carbon at his works at Penn Yan, N. Y., writes to us he is the only Taylor in the country engaged in this work. Recent statements connecting him with the Cowles Company at Cleveland and mentioning a Charles B. Taylor, are incorrect.

MR. EDWARD G. LENDER, who was for some time the chief engineer in charge of the Western Electric Company's works in New York city, has taken charge of the plant of the Prudential Insurance Company of America, at Newark, N. J. Mr. Lender has under his care important interests, and the Prudential company is to be congratulated on securing the services of one so well fitted to look after such an equipment.

MR. ARTHUR F. STANLEY, one of the best-known men in the electrical industry of New York city, has accepted the position of eastern manager for the Robbins & Myers Company, of Springfield, Ohio, manufacturer of dynamos and motors. Mr. Stanley succeeds Mr. C. L. Van de Water, who has resigned to enter other business, and has established his headquarters at 170 Broadway, the fine new Broadway-Maiden Lane Building.

MR. A. FREDERICK COLLINS, who has contributed considerable literature recently to the study of wireless telegraphy and telephony, is one of the regular lecturers for the board of education, and has been meeting with considerable success in delivering this subject in a popular and scientific way. Mr. Collins will lecture on "Operative Systems of Wireless Telegraphy" on Tuesday evening, November 25, before the New York Electrical Society.

OBITUARY NOTICES.

The body of John W. Mackay, who died in London on July 20, has been brought to the United States, attended by Mrs. Mackay and her daughter, the Princess Colonna. The coffin was taken to Greenwood Cemetery, Brooklyn, followed by the friends and relatives in carriages. Father Ducey conducted the burial service, and the body was placed in the Mackay mausoleum at Greenwood.

MR. CHARLES MOEHLMAN, foreman of the iron foundry of the General Electric Company, Schenectady, N. Y., died suddenly at his home in Schenectady on Friday, October 31. Mr. Moehlman was born in Mittelstadt, Westphalia, in 1856, receiving a common school education and learning the moulder's trade in his father's foundry. At the age of twenty-one he had the usual term of three years' service in the German Army. Coming to America in 1882, he was employed for four years in an iron foundry in Amsterdam, N. Y., working in several other foundries until 1888, when he became a moulder with the General Electric Company, continuing in its employ until his death. He was appointed foreman of the iron foundry in 1895. A widow and six children survive him.

PROFESSOR OGDEN N. ROOD, head of the department of physics at Columbia University, died on November 11 of pneumonia at the Vanderbilt Hotel, New York city. Professor Rood was born in Danbury, Ct., seventy-one years ago, and entered Yale at eighteen, but after completing his sophomore year went to Princeton, taking his art degree with the class of 1853. For two years after graduation he was instructor in chemistry at Yale. He then went to Europe, working for three years under Liebeg, returning to the United States in 1858 to take the chair of physics in Troy University. At the same time he filled the post of professor of rhetoric and logic. After the disbandment of Troy University soon after the breaking out of the Civil War, Professor Rood went into retirement at his country residence (Peacedale) in Rhode Island. In 1864 he became professor of physics at Columbia. Professor Rood was widely known through his original investigations on color, writing much on this subject, notably on "Modern Chromatics." In later years the Rœntgen ray engaged his attention, and in the early development of this phenomena he was one of the most prominent investigators. He carried out to a very great degree many researches upon the electrical conductivity of insulating materials. During the last year Professor Rood devised a new method of measuring electrical resistances, capable of dealing with very high potentials.

ELECTRIC LIGHTING.

ELKTON, MD.—The plant of the Elkton Electric Light Company will shortly be doubled in capacity.

LATROBE, PA.—The Latrobe Electric Light Company has been sold to the Latrobe Street Railway Company, the price being about $500,000.

NEW LONDON, CT.—The New London Gas and Electric Company will double the capacity of its power plant. The work is to be completed by next June.

BOISE, IDA.—A large electric plant is being put in at Payette, Ida. This will furnish light and power to a large number of mines in the vicinity of the town.

PITTSBURG, PA.—A building permit has been issued to the Pittsburg Railways Company for its new power-house on Brunots Island. The structure is to cost $100,000.

HOUGHTON, MICH.—The Houghton County Electric Light Company will double the capacity of its present plant. The work will cost $100,000, and will be completed by April 1, 1903.

CAPE MAY, N. J.—Improvements to the Cape May Light and Power Company's station are progressing rapidly, and it is expected that everything will be in readiness by the first of February.

NIAGARA FALLS, N. Y.—The town board has granted the Ontario Power Transmission Company the franchise recently applied for by the company. This provides that the company shall have 5,000 horse-power ready for use in three years.

MANISTEE, MICH.—Louis Sands has sold his lighting plants to the Manistee Gas and Electric Company, a newly organized corporation with a capital of $200,000. The transfer involves the transfer of both plants, mains, franchises and street lighting contract, and dates from November 1.

PLAINFIELD, N. J.—A new power-house is being built at Cranford for the Elizabeth, Plainfield & Central Jersey Railway Company. This will furnish power for the entire line, and the equipment will be such that in case of accident there will be no interruption in the operation of cars.

PHOENIXVILLE, PA.—The Schuylkill Valley Illuminating Company will at once begin the erection of a large power plant one mile north of this place. Electrical power will be furnished to Phoenixville, Mont Clare, Spring City, Royersford and other near-by towns. Work will be completed by January 1 next.

PITTSTON, PA.—It is reported that the Erie company is about to introduce electricity into the majority of its mines. The power will be used to light the mines, propel motors, work drills and cutting machines and operate electrical machinery in the breakers. The cost of the new plant to be erected is said to be in the neighborhood of $60,000.

CENTRALIA, MO.—A controlling interest in the Centralia Light and Power Company has been sold to a syndicate composed of the following parties: M. M. Stephens and W. S. Forman, of East St. Louis; L. D. Turner, of Belleville; M. M. Bylisby and J. S. Cummings, of Chicago, and W. F. Bundy, of St. Louis. The officers of the new company are: M. M. Stephens, president; H. M. Bylisby, vice-president and general manager; L. D. Turner, secretary, and Harry Kohl, treasurer. The new management intends to extend and improve the plant of the company.

ELECTRICAL SECURITIES.

Quite a period of demoralization set in during the past week, and the conditions placed many conservative interests in jeopardy on more than one occasion. The liquidation has been very extensive, and has come as the result of rich and powerful operators and pools, as well as from investors and small-margin speculators. While these conditions have no doubt been the weighing cause of the market's bad appearance, the primary reason for the distress is no doubt the monetary situation. It is predicted, however, that a crisis has been reached in adverse conditions and that the worst that has happened through the volume of liquidation has been a strengthening of the financial and speculative possibilities. A comparison of prices at the close of the market this week with those of about the first of September show how large has been the shrinkage of values and the lessening of credit and resources.

Last week the cash balance of the United States Treasury was reduced to $52,000,000, or $2,000,000 above the theoretical limit of safety. The foreign trade up to the present time is not as great as was expected, the excess of exports amounting to $55,692,000, as against an excess of $64,212,000 for October of last year. For the ten months of this year the excess has been $296,690,000, as against an excess in the same period in 1901 of $464,054,000. It is expected, however, that this will be very largely redeemed in the immediate exports of corn and cotton.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 15.

New York:	Closing.
Brooklyn Rapid Transit	58⅛
Consolidated Gas	213¾
General Electric	181½
Kings County Electric	209
Manhattan Elevated	134⅜
Metropolitan Street Railway	136¾
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	190

The directors of the Kings County Light, Heat and Power Company have declared the regular quarterly dividend of 1½ per cent, payable December 1. The stock of this company made an advance to 209 for the week.

Manhattan Elevated made a good report, showing that the economies which were expected to result from the electrically equipping of the company's trains have evidently materialized. In fact, the cost of operation has decreased from about 55 per cent of the gross earnings last year to 50 per cent this year. Aside from the economy in operation, however, the expansion in general business is most conspicuous. On an increase of 15 per cent in gross earnings for the year, the number of passengers carried has increased 15 per cent, or over 29,000,000.

Boston:	Closing
American Telephone and Telegraph	161
Edison Electric Illuminating	265
Massachusetts Electric preferred	96
New England Telephone	136
Western Telephone & Telegraph preferred	98

Boston had a good share of recovery for the week, and the prominent specialties rallied well. Massachusetts Electric rallied 1⅛ to 36¾, a loss of ⅞ for the week.

American Telephone, at 161½, is off 1½ from last week.

Philadelphia:	Closing.
Electric Company of America	9⅛
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	8½
Union Traction	46⅜
United Gas Improvement	111

Notwithstanding the recent denials as to statements regarding the Philadelphia Electric merger with the Philadelphia Rapid Transit Company and the United Gas Improvement, and as to the taking over of the Philadelphia waterworks, considerable talk is extant as to something happening in this direction in the early future.

Chicago:	Closing.
Chicago Edison Light	107
Chicago Telephone	168
Metropolitan Elevated preferred	85
National Carbon common	30
National Carbon preferred	100
Union Traction common	18
Union Traction preferred	50

ELECTRIC RAILWAYS.

BANGOR, PA.—The Blue Ridge Traction Company expects to have its line from Walnutport to Danielsville—a distance of seven and one-half miles—completed by December 1, and at the other end from Nazareth to Bath—a distance of four and one-half miles—by the first of the year.

LOS ANGELES, CAL.—The engineers now engaged in laying out the route for the San Jose, Saratoga & Los Gatos electric railway will soon complete their work, and every effort will be made to have the cars in operation by May 1, 1903. The work of actual construction will be commenced about December 1.

WASHINGTON, PA.—A charter has been granted to the Greene County Rapid Transit Street Railway Company, with a capital of $50,000. The directors are: T. J. Wisecarver, Judge R. L. Crawford, T. S. Crago, L. W. Sayers and W. D. Cotterrel. They propose building lines from West Waynesburg to Morrisville.

FORT WORTH, TEX.—The survey for the electric line which is to be built between Beaumont and Houston has already been completed to Sour Lake and the survey from Sour Lake to Houston will be undertaken very soon. The road is to be both a passenger and freight traffic, and is to be constructed as soon as possible.

ROME, GA.—The city electric company has decided to extend its line from this place to Lindale, six miles south of Rome. The company will erect a new power-house at Mobley Park. When the extension is completed the company will have a trackage of eleven miles. The improvement will cost in the neighborhood of $250,000.

HOUSTON, TEX.—It is stated that the Northern Railway Company proposes to build an electric line from Houston to Galveston, skirting the bay shore and taking in all of the summer resorts along the route. Application has been made for the right of way into Houston, and much of the county right of way along the route has been secured.

SYRACUSE, N. Y.—The Syracuse Rapid Transit Company will build a high-speed electric road between Oswego and Liverpool. Cars will be run at the rate of fifty miles an hour. The total cost of the road will probably be $800,000. Work will be commenced in the spring, provided the franchises and necessary leases can be secured by that time.

INDIANAPOLIS, IND.—The Fort Wayne, Bluffton & Richmond Traction Company has been incorporated with a capital of $50,000. The company proposes to build an interurban line from Fort Wayne to Richmond. The incorporators are: Edward Manier, of Versailles, Ohio; Frank X. Schaffer, of Dayton; Charles Durst, of Dayton; Charles F. Manning, of Dayton, and William F. Dinnen, of Fort Wayne.

ITHACA, N. Y.—Surveyors have begun work on the trolley line connecting Ithaca and Auburn, and franchises for the line are being secured. The company has $2,000,000 ready to build the road, and construction will be pushed with the greatest possible haste. The road will probably make connection with the Moravia-Syracuse trolley line, thus making a continuous route by trolley from Ithaca to Syracuse. There is also talk of an extension from Ithaca to Oswego.

NORRISTOWN, PA.—The charter of the Souderton, Skippack & Fairview Electric Railway Company has been recorded. Its route extends from Souderton to Trooper, and the capital stock is $100,000. The directors of the road are: A. G. Reiff, Souderton; E. S. Moser, Collegeville; A. C. Alderfer, M. C. Clemens, Harleyville; H. W. Reiff, Lederachville; J. N. Hunsberger, B. W. Dambly, Skippack; John R. Cassel, Cedars; W. A. Schultz, George K. Mischter, Worcester; William M. Anders, Fairview. E. S. Moser is president. The length of the road will be sixteen miles.

ELKTON, MD.—It has been definitely decided by the Kent & Cecil Railway Company to build an electric road between Newark, Del., and Chesapeake City, Cecil County, *via* Elkton. The company's representative recently appeared before the county commissioners and deposited $1,500 as a guarantee that the road would be in running order by October, 1903, and that work would commence within five months. The commissioners then granted the company the exclusive right from the Delaware State line to Elkton, and also the right of way from Elkton to Fredericktown, on the Sassafras River.

INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is disposing of a great many Adams-Bagnall arc lamps for store lighting. These lamps are claimed to be very efficient and attractive for this class of service.

THE EUGENE DIETZGEN COMPANY, New York, Chicago, San Francisco, manufactures many specialties for the engineer's use. The automatic revolving cylindrical blue-printing machine manufactured by this company is carefully described in other columns of this issue.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has recently issued a new general catalogue for 1903, and is distributing it to the trade throughout the country. Any buyer of electrical supplies who has not received a copy can do so by addressing a request to the company.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has issued a small booklet entitled "The Distribution of Light from the Nernst Lamp." This contains some very interesting reading on the subject of illumination, and is of practical value to any one looking at the question of electric lighting.

THE PHOENIX GLASS COMPANY has removed its Chicago office and salesroom to No. 206 Wabash avenue. A complete line of samples will be on exhibition at this place, and a cordial invitation is extended to the trade to visit the company's new quarters. Mr. E. H. Fox is the western agent.

THE AMERICAN INSULATED WIRE AND CABLE COMPANY, Chicago, Ill., has made such material progress during the last few months under the efficient management of Mr. Brenner that it finds it necessary to take additional space, which will give it increased facilities for the handling of a large amount of business.

THE B. W. PAYNE COMPANY, 39 Cortlandt street, New York city, is now prepared to do all kinds of repairing on electrical and steam machinery at its Brooklyn branch, 45 York street. This company has a new storeroom connected with this establishment, and has on hand quite a stock of apparatus for immediate use.

THE DEVEAU TELEPHONE MANUFACTURING COMPANY, New York city, has furnished a complete telephone exchange equipment to the Trinidad Electric Company, and the same has been shipped to Trinidad. This company has also furnished the United States Government with a complete central energy plant for the Puget Sound naval station, Brennington, Wash.

THE RUSSELL & ERWIN MANUFACTURING COMPANY, New Britain, Ct., has placed a contract with B. H. Hibbard for the construction of a new manufacturing building fifty feet wide and 200 feet long, with a height of seven stories. The construction will be fireproof througnout, and it is expected that the building will be completed and ready for use about February 1.

THE SIMPLEX ELECTRIC HEATING COMPANY, Cambridge, Mass., has just completed a handsome factory building adjacent to its present one, giving the company, when occupied at the end of this month, over three times its present capacity, with the most modern appointments to facilitate the work. The company reports great progress in securing orders for its apparatus.

THE SHULTZ BELTING COMPANY has added new buildings to its plant at St. Louis, Mo., increasing its capacity two and one-half times, and has also added a full line of modern machinery. This includes the latest improved stretching machinery, an exclusive device by which the stretch is taken out of the belting. This company will be pleased to send full information regarding its output upon request.

THE POWER INSTALLATION COMPANY, New York city, tendered a standing luncheon to a number of its friends on November 1. This was the occasion of the opening of the company's new suite of offices, 37, 38, 39 and 40 Exchange Building. The reception committee consisted of Messrs. George F. Westcott, O. H. P. Fant, Otis H. Westcott, Oliver H. Firkins, Wesley Pettapiece, Charles Schmidt and Fritz Berlin.

VALLEE BROTHERS ELECTRICAL COMPANY, 625 Arch street, Philadelphia, Pa., is sending to any one interested two splendid catalogues on telephone apparatus and electrical house goods. These would seem to cover a range of everything which could be looked for in small electrical apparatus, applying to hotel annunciators, telephones, telegraph instruments, batteries, construction materials, wires and cables, and a great many other electrical devices.

THE CHICAGO FUSE WIRE AND MANUFACTURING COMPANY has recently established a new factory at 187 Pratt street, Buffalo. The purpose of running a factory here was with the idea of being nearer the Atlantic coast electrical interests, and also because the company's business has so rapidly increased during the last few years as to practically grow beyond its Chicago manufacturing facilities. The company continues its office at 358 Dearborn street, Chicago, and also its Chicago factory, and also maintains an office at 853 Broadway, New York.

P. & F. CORBIN, New Britain, Ct., is making extensive changes in its plant in order to increase the output. There has been completed for it a large, seven-story, fireproof building, to be used for general manufacturing purposes; and work is now going on for a new factory building located on its property at its "annex," adjacent to the tracks of the New York, New Haven & Hartford Railway Company. These improvements will necessitate the employment of 100 additional iron moulders and 500 extra help in general manufacturing, and the building is expected to be completed about January 1.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., the manufacturer of Sederholm boilers for high pressures and large units, is publishing the results of recent tests of these boilers. These results are in the form of a report by Albert C. Wood, mechanical engineer, of Philadelphia, Pa. The report takes up the object of the tests, a description of the boilers, coal used, the method of conducting the tests, the gas analysis, and the results of the trials. The whole subject of the trials is summed up in a recapitulation which gives some very interesting and practical information in regard to this branch of engineering.

THE STANDARD POLE AND TIE COMPANY, 44 Broad street, New York city, is about to move its North Carolina office from Maxton to Wilmington. The office in Maxton has been carried on for the last two years, but it now appears that it would be more to the company's advantage to have its office located in Wilmington. Mr. J. W. Davis, who is the manager of the North Carolina office, has personal charge of the shipment of the octagonal and juniper poles from that section, and has also supervision over the inspectors who subject to a rigid examination every carload of material before it is shipped. All communications relative to the purchasing of material should be addressed to the New York office.

THE LOWELL INSTITUTE'S advanced free courses of lectures for the term of 1902 and 1903 have been announced. The trustee of the Lowell Institute maintains, under the auspices of the Massachusetts Institute of Technology, this course of twenty free lectures. These cover a wide range of subjects in pure and applied science, as well as in literature. Each lecture is given by a member of the faculty of the Massachusetts Institute of Technology, and is carefully adapted to the needs, on the one hand, of teachers desiring to continue their studies, and, on the other, to men engaged in technical observations, in which they desire further scientific training.

THE GARRIGUS MECHANICAL BOILER CLEANER COMPANY, through its selling agent, Coe, Smith & Company, of Chicago, reports the following recent installations: St. Louis Car Company, American Can Company, Bay Cities Consolidated Railway, Swift & Company, Republic Iron and Steel Company, Fort Wayne Gas Company, Cudahy Packing Company, Harmon Brothers, of Omaha, and the Illinois Brick and Industrial Works, Bay City. The company is meeting with great success with its mechanical cleaner, which is being adopted by a large number of leading corporations and lighting plants throughout the country. The order received from the Fort Wayne Gas Company is the third order from that company, which now has fourteen cleaners in operation. The last order from the Cudahy Packing Company makes fifty-eight cleaners installed in boilers in its different plants.